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Risks, Lessons Learned, and Secondary Markets for Greenhouse Gas Reductions

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Emissions trading could significantly reduce the costs of limits on greenhouse gas emissions. Complementary domestic policies to reduce fragmentation in evolving secondary markets, establish clear baselines and procedures, and strengthen host-country institutions could further reduce the risks and costs of emission limits.

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Summary findings

Collectively or individually, countries are likely to implement policies designed to limit greenhouse gas emissions. Experience from tradable quota schemes suggests that emissions trading could significantly reduce the costs of emission limits.

The Kyoto Protocol provides the framework for a common trading mechanism for all countries — including countries that would not face immediate emission limits. Significantly, the Protocol places the responsibility for meeting emission limits with national governments.

How policymakers choose to implement emission limits will significantly shape the incentives that drive evolving secondary markets for greenhouse-gas-based instruments. Potential market participants who were surveyed rate policy-related risk as higher than business-related risks.

Domestic policies designed to reduce fragmentation in secondary markets, establish clear baselines and procedures, and strengthen host-country institutions can all help reduce the risks and costs of emission limits.

This paper — a product of the Development Research Group — is part of a larger effort in the group to support more cost-effective environmental regulations. Copies of the paper are available free from the World Bank, 1818 H Street NW, Washington, DC 20433. Please contact Pauline Kokila, room MC3-544, telephone 202-473-3716, fax 202-522-1150, Internet address pkokila@worldbank.org. Policy Research Working Papers are also posted on the Web at http://www.worldbank.org/html/dec/Publications/Workpapers/home.html. Donald Larson may be contacted at dlarson@worldbank.org. March 1999. (54 pages)

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RISKS, LESSONS LEARNED AND SECONDARY MARKETS FOR GREENHOUSE GAS REDUCTIONS

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I. INTRODUCTION

Viewed simply, free markets fail to capture the full but uncertain costs of releasing additional greenhouse gases into the earth's atmosphere. Moreover, the effects of additional greenhouse gas emissions are global rather than local, so that a ton of carbon released into the atmosphere will have substantially the same effect on the climate regardless of the source. The framework agreement discussed in Kyoto recognizes the global nature of the problem and proposes how greenhouse gas emissions might be limited by international treaty. Further, proposed implementation mechanisms -- including joint implementation, the Clean Development Mechanisms and emission trading-- offer the potential for global incentives to reduce emissions wherever they are to be had at least cost. This is significant, since experience has shown that public expenditures are insufficient to affect measurably affect the global problem. Consequently changes in incentives are crucial to change private activities and redirect private investment.

The purpose of this paper is to look at the incentives and markets these mechanisms are likely to engender. Moreover, risks will be examined as well since they are central to investment decisions. In turn, because the Kyoto framework is designed to address a market failure, the incentive and risks it fosters will be dependent on implementing agreements and institutions rather than underlying consumer demand. Although less common, this type of market is not unique and lessons from similar markets are presented.

Subsequent to this introduction, the paper is organized as follows. The second section of the paper speculates on how joint implementation and an international market for carbon credits might work and analyzes different components of risk along the marketing chain. Risk management lessons are drawn from other markets, including markets for tradable emission permits and tradable quotas. Section three presents the results from a survey of potential market participants on their perception of future markets for carbon credits and associated risks. Section four concludes. Additionally, an Annex is provided containing more detailed information about five of the tradable permit and quota programs from which lessons are drawn and presented in earlier sections.

II. Carbon Credits, Risks, and Secondary Markets

Greenhouse gases, international treaties and assumptions about markets

The earth constantly receives energy from the sun, mostly as visible light, and radiates energy back into space, primarily as invisible infrared light. Water vapor, clouds and the long-lived gases, including carbon dioxide, reduce the outflow of radiated light creating an energy imbalance known as the "greenhouse effect". It is widely believed the accumulated release of carbon dioxide from combustible fossil fuels over the past century has increased the energy imbalance resulting in a warming of the earth's surface. The consequences for the earth's climate however are not known and the processes poorly understood. Extreme climate changes have occurred naturally and it is unclear how human activity might influence natural cycles. Mathematical modeling exercises suggest that under some circumstances, the consequences can be severe and carry significant risks and costs for society[1]. This is especially true if the pace of climate change overwhelms the adaptive abilities of biological systems. However, similar models also show that the costs of limiting emissions can be high and are sensitive to implementation choices. Further, the costs and benefits of climate change and emission limits are not equally shared, and any course of action will have distribution effects.

Potential adverse effects of climate change represent a common problem for all nations, and in recent years, the United Nations Framework Convention on Climate Change has provided an institutional setting to discuss and implement joint solutions. A product of that convention, the Kyoto Protocol, provides an initial framework for an agreement on greenhouse gas emission goals and suggests several ways in which the costs of emission limits can be lowered[2]. Chief among these are provisions for emissions trading and joint implementation. Under the terms of the agreement Annex I[3] countries -- would reduce their emission levels from 1990 levels in a 2008-2012 commitment period and show progress toward meeting those reductions by 2005.[4] Potentially, countries in deficit can purchase emission allowances from countries in surplus or earn carbon credits by investing in projects that reduce emissions elsewhere -- including countries that have not agreed to constrain emissions. Broadly, such investments are known as joint implementation schemes, however a distinction is made in the Kyoto Protocol between projects arranged by two Annex I countries and other projects.[5]

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[1] Model results are reviewed in *The Kyoto Protocol and the President's Policies to Address Climate Change: Administration Economic Analysis* at http://www.weathervane.rff.org/refdocs/wh_analysis.pdf

[2] See Jacoby, Prinn and Schmalensee (1998) for an excellent overview of climate change issues and the role of the Kyoto Protocol.

[3] Annex I is a list comprising 39 developed and transitional economies: Australia, Austria, Belarus, Belgium, Bulgaria, Canada, Czechoslovakia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Latvia, Lithuania, Luxembourg, Netherlands, New Zealand, Norway, Poland, Portugal, Romania, Russian Federation, Spain, Sweden, Switzerland, Turkey, Ukraine, United Kingdom, and the United States.

[4] The Protocol goes into force when Parties to the Convention signing the Protocol represent 55% or more of the total 1990 CO_2 emissions.

[5] The Kyoto Protocol defines a Clean Development Mechanism under which Annex I countries promote emission reductions in non-Annex I countries in exchange for credit against emission limits, reserving the term joint implementation for projects among Annex I countries. In addition, in Kyoto-Protocol parlance, the carbon credits generated by joint implementation projects are termed "earned reduction units" while credits generated under the Clean Development Mechanism are called "certified emission reductions."

Currently, joint implementation projects are largely experimental, and the compensation mechanism is usually a public or private grant[6]. However, the Kyoto Protocol envisions a legal and regulatory framework that would credit project owners for reducing emissions. The credits are offsets against a presumed alternative -- or counterfactual. Project owners are rewarded or credited for this hypothetical reduction in kind-- that is, the credits are denominated in tons-of-carbon. The credit can be used to offset emissions elsewhere, or perhaps to pay for energy taxes.[7]

The cost of producing credits will be determined by the additional costs of reducing emissions by adopting the lower-emission technology or developing additional carbon sinks, and participants will seek out low-cost reductions across national borders. However, the value and utility of a carbon credit will depend, in addition to normal supply and demand conditions, on policy set out by the international agreement, and the domestic policies established to implement the agreement. Users of "imported" carbon credits may well have scope for choosing the country hosting joint implementation projects, but will face prevailing home-country rules when using credits. Consequently, identical carbon credits can have potentially different values depending upon where they are used.

In order to look at how secondary markets might operate, we must speculate on what a working international agreement might look like. For the purposes of this paper, we will assume that an international agreement is reached along the lines of the Kyoto Protocol that allows joint implementation projects for tradable credits against country emission limit commitments. Country governments will retain responsibility and authority on how the agreement is implemented within their borders as long as the implementation conforms to the broader international framework agreement. Consequently, the markets for credits will be affected by the domestic policies of governments hosting joint implementation projects and by the policies of governments in which the credits are used. Later we further distinguish among three approaches that Annex I countries might take toward tradable credits when managing their emission limits. The three categories are drawn from historic approaches toward emission controls and are also based on positions put forward during the on-going debate over post-Kyoto implementation strategies[8].

The marketing chain for carbon credits

In this section we turn our attention to the likely way in which carbon credits might be created, sold and used. This process is depicted in Figure 1. Generally, offsets can be created by making additional investments in a project that reduce greenhouse gas emissions-- for example, refitting a power generation plant to burn fuel more efficiently. The "credit" earned for this investment is determined by the difference between the "clean" version and a counter-factual baseline of "what would have been." It is likely that local institutions will monitor and verify the process of generating the credits -- a process that can span many years. Once verified, the credits

6 The UNFCC surveyed governments, international organizations and NGOs on their joint implementation -- also known as actions implemented jointly (AIJ)-- activities. Their report can be viewed at: http://www.unfccc.de/fccc/docs/1998/sb/misc02.htm. The US General Accounting Office has also issued a report on the US JI program, "Climate change: information on the US initiative on Joint Implementation." (GAO/RCED-98-154.) The report attempts to measure the benefits of the US program, but notes that JI program staff "do not verify or attest to the reliability of the net greenhouse gas benefits" because of lacking standards.

7 Currently in Denmark, some companies meeting voluntary energy-conservation goals qualify for tax relief.

8 For example, see Downie et al. (1998) for a recent review of EU country positions on emissions trading

must be recognized or certified as meeting the international standards for tradable credits established under the international agreement. Governments are ultimately responsible for meeting reduction targets pledged in Kyoto and government policy will determine how credits can be used domestically.

Markets are likely to evolve as the process is implemented. Broadly, these would include markets associated with carbon credit projects -- for example a market for bonds financing carbon-offset projects; markets in certified credits[9] -- including perhaps spot, forward and futures markets; and finally domestic markets that are potentially poorly integrated with international markets. Below, we look at some of the risks associated with each stage of the process and with evolving markets.

Project level risks

During the planning stage, investors will need to determine the how many credits will be generated by the project, and at what cost. Since the offsets are generated against a counterfactual or *baseline*, clear rules must be established in order for the firm to estimate costs and benefits. To qualify for credits, the project managers must determine *additionality* -- that is they must show that the reductions claimed are above and beyond reductions that would have taken place without the project. Since a project may be long-lived, determining additionality may mean estimating reductions against forecasted changes in technology.[10] Further, factors such as project or country risk also determine whether investments of a certain type are reasonable alternatives.[11] Moreover, if the country is subject to overall emission budget, there is an additional constraint that the budget is not exceeded.[12]

Often in project financing, the planning and construction phase of a project is considered riskier and less secure than the financing of on-going firms. Consequently, project financing is often structured to reflect the changes in risk as the project is developed. Below, we consider two phases of project risk.

[9] London's International Petroleum Exchange and the Sydney Futures Exchange have put forward separate proposals for trading Kyoto-based emission allowances.

[10] Goulder and Mathai (1997) discuss this issue in detail.

[11] In the Kyoto Protocol, the concept of additionality is addressed in Article 12.

[12] See Chomitz (1998) for a treatment of baselining and additionality issues.

Project preparation and construction

Establishing appropriate standards will likely remain the province of governments, however private firms -- for example, engineering firms -- are likely to take part in the process as well. Consequently, components of both *policy risks* and *private performance risk* will be present in determining the hypothetical reduction in emissions. At the project preparation stage, the primary private performance risks concern the company's own calculations about the process generating the credits --for example, assumptions about the performance and cost of the technology or the profitability of the project. In addition, the sovereign or policy risks can be multifold. Under current joint implementation experiments, sponsoring countries are primarily responsible for approving joint implementation projects and criteria differ from country to country. Even under the more structured framework envisioned by the Kyoto Protocol, sponsoring countries may well retain some authority over project qualification. Moreover, host countries may also want to participate in defining additionality and project qualifications -- especially if the joint implementation project affects the host-country baseline. Potentially, the two definitions could conflict. Moreover, large energy projects such as hydroelectric dams are years in the planning. For such projects, the policies of either country, or even the international agreement itself, could change materially during the preparation and construction.

Project life risks

During the life of the project other risks emerge. Chief among these is the underlying economic performance of the project. For example, a biomass project might function exactly as engineers predict, but fail because of a decline in the demand or price of electricity. For regulated industries in particular, the economic performance may be dependent on policy as well. Indeed, shutdowns may well increase as energy markets liberalize and specialization occurs. Who bears such risks depends partly on ownership. For example, joint implementation investors who hold bonds rather than equity may face different levels of exposure.

Additional risks may stem from price fluctuations for the underlying carbon credit. The economic performance of the project may be threatened if the credit revenue is crucial to the success of the project. Alternatively, if the firm is obligated to provide a certain tonnage of credits to investors, investors take on price risk. If secondary markets and hedging instruments emerge-- issues covered later in this paper-- then risks might be dispersed to third parties.

Finally, the rules of the game can change during the life of the project. Changes in baselines, domestic regulatory requirements, changes in the destination market policies can all occur during the life of the project. At one extreme, international law recognizes the sovereignty of nations over their natural resources and countries have the authority to simply nationalize emission credits. Or, in a less extreme case, a cap-and-trade[13] destination country might make marginal changes in the cap, changing supply conditions and prices.

Monitoring, verification and certification

Generated emission reductions must be verified. For most projects this means comparing measurable emissions over time against an unmeasurable counterfactual baseline, and on-going monitoring may be required. Possibly, as with some programs designed to limit air pollution in the United States, continuous monitoring equipment might be used. Third party inspectors might be

[13] Cap-and-trade regimes are discussed later.

hired to validate the reduction, much like independent auditors or commodity quality inspectors. Verification might automatically lead to certification -- perhaps subject to possible ex post review. Alternatively, a review process may be required prior to certification.

The Kyoto Protocol is open to interpretation, and modalities for verification and certification are works in progress. However, it is likely that the authority for establishing broad criteria and ultimate authority for certification of emission reduction units will rest with an institution established by the agreement. Still, practical issues of implementing the validation process will most likely fall to governments. In turn, governments may choose to empowering private inspectors, enforcing quality through spot checks.

In practice, there are likely to be large differences in the reliability and timeliness of various host country institutions engaged in verifying carbon offsets. Failures in validation negate any environmental improvements and could erode overall support and confidence for the international agreement. Risks associated with delays or failures in validating and certifying bonifide offsets fall to the owners of the credit rights.

Investors, users and secondary markets

Users of carbon credits may choose to generate credits through direct investments or they may choose to purchase certified credits. Direct investments may be managed internally within the firm, or, as discussed later, firms may want to diversify their risks by participating with other investors in a pool of projects. Regardless, it is unlikely that all firms would want to, or be able to manage both the supply and demand for credits internally. Even investors in pools will face the risk that the fund will under perform, producing too few or poorly timed credits. Such risks become less problematic if efficient secondary markets exist from which to purchase or sell additional credits as needed. Storage, or in this case, the ability to save reduction credits for future use, facilitates liquidity as well and reduces volatility.

Transaction costs are higher when markets are thin. Under such circumstances quoted prices become less reliable and large purchase or sell orders can move the market against large volume buyers or sellers and encourage private placements. Further, for planning and risk management purposes, users might want to purchase forward or perhaps purchase options on future credits. Consequently, the market works best when spot, forward and option markets are liquid.

Liquid and efficient markets are characterized by many active buyers and sellers, high volume and abundant information. Transactions involving heterogeneous items require more information and it is frequently harder to match buyers and sellers. For example, markets for commodities or US Treasury bills tend to deal in homogenous goods, so transactions are enacted quickly and at low cost. On the other hand real estate markets or deal in more heterogeneous goods, so search and closing costs are higher.

The issue of heterogeneity is potentially problematic for carbon-credits based assets prior to certification since the risk characteristics of joint implementation projects and country-based regulatory institutions will differ. Until credits are standardized through certification, buyers will want to distinguish among carbon-credit assets based on the time, host-country and project characteristics.

Domestic markets for credits

As stated earlier, governments are likely to retain authority over the domestic use of carbon credits. Profoundly different views exist about the appropriate instruments for achieving emission reductions. Country experiences and country energy sectors differ as well and it is likely that diverse approaches will emerge as countries begin to implement reduction strategies. Consequently, incentives to invest in greenhouse gas reductions will differ among countries as well. This point is illustrated by examining three dominant approaches that are likely to emerge.

Cap-and-trade approach

Under cap-and-trade emission regimes, governments allocate a fixed number of emission allowances or permits to private and public entities and require all significant emitters to match permits and emissions. Tradable permits are an important component of the US Acid Rain program for example, and two Canadian regional pilot programs, are applying the approach to greenhouse gas emissions based on voluntary reductions [14]. The Japanese Ministry of International Trade and Industry also supports emission-trading pilots. For the purposes of discussion, we will assume some governments will choose to allocate emission allowances to public and private permit holders and that these permit holders are free to trade permits within the country and with private and public entities of other countries that limit emissions. Further, we assume that additional permits can be created through properly certified joint implementation projects in any country.[15] Some countries may choose to place limits on the number of new permits generated through joint implementation.

In the stylized cap-and-trade system presented here, the government allocates, for each time period, a fixed set of emission permits[16]. This allocation, plus any banked permits, is represented by *Quota* in Figure 2. In addition, credits from other countries can be imported to supplement domestic permits. The curved arrow in the figure represents the supply of credits -- quota, savings plus credits.

Under cap-and-trade regimes, emissions must be matched with permits at the end-of-the accounting period. Consequently, carbon-based fuels must be consumed jointly with permits and we would expect the demand curve for credits to look something like a derived demand curve for carbon fuels. This is represented by the downward sloping line.[17]

As drawn, the consuming country is a price taker and the international price of greenhouse gases credits would prevail domestically. In turn, the price of credits would equal the marginal cost of generating certifiable emission reductions. The country would import a portion of the international supply of credits. The effects of trade are to decrease the permit price from Pd to Pw and increase emissions from the country from *Quota* to *Qt*. The net effect globally on emissions is

[14] These two Canadian programs are British Colombia's GHG Reduction Trading Pilot Project and Ontario's Pilot Emissions Reduction Trading Project.

[15] Policy makers charged with negotiating Kyoto implementation usually distinguish between trading allowances among Annex I countries and trading credits generating by JI projects. Several countries oppose emission trading in general and propose strict limits on the use of JI credits. These countries emphasize burden sharing and see emissions trading as a way of shirking agreed upon commitments.

[16] For a description of a working cap-and-trade program, see the US SO_2 market case study in Annex I.

[17] A cautionary note is in order. Mapping out demand and supply curves requires a homogenization of the credits. As noted earlier, the credits all carry project-specific, country-specific risks that would differentiate credits and fragment markets. We will return to solutions from other markets later.

zero, since the credits were generated by reductions elsewhere. Should prices rise above Pd, the country would export credits.[18]

Carbon-tax approach

Several countries have proposed using a fossil fuel tax to limit domestic demand for carbon-based fuels and thereby limit emissions. A carbon-tax was proposed for the EU and several countries, including Finland, the Netherlands, Norway and Sweden have levied carbon-taxes in the past. For the discussion below, we assume some countries will use a carbon tax to manage overall emissions, but will allow private firms to use tradable joint implementation credits to meet tax obligations.

The effects of a carbon-tax policy can be quite similar to a cap-and-trade system under certain circumstances. In Figure 3, the downward sloping line represents the demand for greenhouse-gas-emitting fuels. The price for the fuels, inclusive of the carbon tax, is Pe + t. If all firms are allowed to always substitute credits for taxes *and* if the price of credits is less than the tax, then Pe + c, where c is the cost of the credit, becomes the relevant marginal price of fuels, and consumption increases from Qt to Qc. The effects on the environment are neutral, since the consumption is offset through reductions elsewhere. However, unlimited substitution drains government treasury revenue, so countries may choose to limit the number of credits. In this case, the marginal price of fuel remains at Pe + t. The substitution results in a transfer equal to the area market TR in Figure 3.

Alternatively, if the carbon tax (t) is cheaper than emission credits (h), firms will choose to pay the tax rather than purchase the credits. The impact on the environment is negative, relative to pricing the emission at world prices. Fuel consumption remains at Qt rather than falling to Qh and emissions do not decrease.

Central-control approach

Many countries have taken a regulatory approach to limiting emissions and some will most likely continue to do so in the future -- especially where underlying energy markets are non-competitive. For these countries we assume that regulatory agencies rather than private markets will decide on investments in carbon credits.

Still, governments that chooses to control investments in joint implementation may use a variety of instruments to manage emission limit obligations. In fact, a centrally controlled joint implementation program can coexist with domestic cap-and-trade systems, or a system of managing domestic demand through a carbon tax. For example, governments might limit international trade in permits, but invest directly in joint implementation projects. In such cases, credits generated through joint implementation projects would allow less stringent caps (panel 1 in Figure 4) or lower carbon taxes (panel 2 in Figure 4). However, the domestic cost of carbon emissions however, would only coincidentally equal the marginal cost of carbon reductions through joint implementation.

Alternatively, the government may chose to control emissions by requiring that firms use "best available technologies", or specifying other production controls. Credits generated through joint implementation would allow governments to relax the restrictions somewhat, moving the internal economy closer to the optimal mix of inputs. This is depicted in the bottom panel of

[18] Holling and Somerville (1998) examine the gains from trade in carbon allowance permits.

Figure 4, where industry is allowed to substitute credits for capital. Restricting joint implementation may however artificially increase the domestic price for credits, resulting in a domestic under-utilization of credits.

Risks and final demand

Carbon credits have value because of regulation and law, and risks from changes in relevant regulations will pervade all destination markets. In addition, open systems that allow free trade in carbon credits will face additional price risks, since changes in the international markets for joint implementation credits will be reflected in domestic markets. Changes in technology are likely to affect all markets. In open systems, changes in technology will alter demand and supply conditions and prices. For regulated systems, changing technology will likely result in changing requirements.

The various approaches discussed above will differ in the incentives they offer for private capital to enter the market for joint implementation and in how the marginal cost of producing offsets globally are reflected in domestic prices. The features of the systems are presented in Table 1. Generally, systems open to unlimited credit use will offer more appropriate incentives for private capital flows to low-cost abatement areas. In addition, the marginal cost of generating credits internationally are better reflected in domestic producer and consumer prices. As a consequence however, price risks associated with the carbon-offset market will also be reflected in open domestic markets.

How domestic policies effect the underlying international agreement in the aggregate is difficult to predict. Policies that prevent private firms from investing in joint implementation projects will raise the cost of carbon limits in the aggregate and may erode support for the agreement. Further, a patchwork of domestic policies and domestic prices for abatement will generate different incentives that may prove distortionary, especially for emission-sensitive industries and markets such as aluminum production or deregulated electricity markets. Accordingly, disadvantaged firms, sectors and countries will look for ways to evade or avoid the binding constraints of the international agreement.

Risk management: lessons from other markets[19]

In Table 2, risks associated with the creation and use of carbon emission credits along the marketing chain are broadly classified into three categories comprising private performance risks, sovereign or policy risks, and price risk. Risks of all types differ also in scope. Some risks associated with potential changes in fundamental rules of the game are pervasive and impossible for individual market participants to manage. Idiosyncratic risks that are country or project specific can be more readily handled through pooling and diversification. In this section, we draw on lessons in risk management from other markets and other agreements to suggest ways of handling related risks in the market for carbon credits.

Risks associated with the international agreement

Carbon credits derive their value from the joint implementation process. They exist against a counter-factual and have no intrinsic worth as a consumable good, or an input to production.

[19] See Annex I for a more detailed discussion of individual tradable permit programs.

Genuine reductions in emissions may benefit the public good, but will have no market value until they are recognized and certified for use. Conversely, false reductions, if improperly certified, have market value. As with money, the role of government is central to the creation of credits. Also, like money, credits will be used to meet obligations to government, including in some instances tax obligations. Consequently, the framework agreed upon internationally is fundamental to the development of markets and investments. Experience from other agreements suggest that resolving several key issues listed below will strengthen the agreement and reduce risks faced by investors.

Political economy of agreement

Until agreements reached under the Kyoto Protocol have proved effective in reducing greenhouse gas emissions and in providing a framework for joint implementation, potential investors will fear fundamental changes in the rules of the game. Successful agreements require a commitment by all major stakeholders. In turn, the agreement has to provide clear goals and procedures.

The rise and fall of commodity agreements, including agreements on cocoa, coffee, sugar and tin, during the last thirty years illustrates how failure to include binding agreements from key players can erode support for the agreement. (See Varangis and Larson, 1996.) For example, US resistance to include Cuba led to the demise of one of the sugar agreements. In another instance, countries like Vietnam were able to expand market share at the expense of other producers by remaining outside an agreement on coffee, ultimately contributing to the demise of the agreement. Similarly, there is a concern that differences in regulatory costs under a greenhouse gas agreement would create welfare advantages for those remaining outside of the agreement. For example, consumers in some countries may face higher costs and lower employment opportunities due to the agreement. In addition, because energy-intensive may relocate to countries where emissions are unregulated, the collective environmental gains from the agreement can be reduced as well, thereby eroding the basic rationale for the agreement.[20] Even if all countries are brought into the agreement, differences in domestic credit-use policies can generate differences in the cost of emissions among countries, potentially increasing the cost of reducing emissions globally and locally, leading to artificial trade advantages and eroding support for the treaty.

Successful programs often pass through an extended process of consensus building. As the number of stakeholders rise, this task becomes more difficult. An early tradable permit scheme designed to remove lead from gasoline in the United States proved successful and adaptable in part because of the small number of refiners involved. Tradable quota schemes for fisheries have been successfully employed in Australia, Canada, New Zealand and the United States. However, in Iceland, the government failed to establish a consensus backing tradable quotas and some in Iceland argue that existing quotas immorally exclude citizens from their livelihood. For international agreements, reaching a consensus on what constitutes a fair and just method of resolving environmental problems can be especially elusive.[21]

Often consensus building begins with comparative studies, but ends with a period of deal making. For example, permitted emission levels under the US Acid Rain program and California's smog-reducing RECLAIM program were initially set at non-binding levels with scheduled

[20] See Jacoby et al. (1997) for a review and discussion of welfare burdens and "carbon leakage" from a CO_2 agreement.

[21] See Albin (1995) for a discussion on justice, fairness and acid rain emission reductions.

reductions to facilitate acceptance. If restrictions are based on historic performance, regulated firms are frequently given some choice on the base-year upon which reductions are based. For the RECLAIM program, firms could choose one of four years as a starting point. In New Zealand, fishermen could base their quota on one of three years and could appeal quota decisions. In the New Zealand case, a tribunal set up to hear complaints raised quotas in half of the cases. In some agreements, targeted exceptions are made. For example, during contentious Uruguay-Round negotiations on agriculture, favored programs such as sugar in the EU and tobacco in the US were largely exempted from reform (Josling, et al. 1996.)

Reaching an agreement often involves an "escape" clause, should the costs of the agreement become too high. A series of "safeguards" are built into the Uruguay Round (Croome, 1996.) Likewise, under the RECLAIM program, high market prices for traded permits would trigger a review of the program. In the Dutch covenant with electricity producers, emission limits can be breached under a variety of circumstances.

Managing change

Successful agreements frequently establish the pace of reform as well. Often actions are spread out over multiple years to minimize adjustment costs. For example, tariff reductions mandated under the Uruguay Round of GATT come in ten annual installments for developing countries (Croome, 1996). In the US, the 1990 Clean Air Act set out a phased reform program designed to conclude in 2010. Similarly, the 1997 Kyoto Protocol asks that parties show demonstrable progress by 2005 but defines the commitment period as 2008-2012.

Not all events will be anticipated, new information will emerge and adjustments will be required. Indeed, the Kyoto convention (Article 9) calls for periodic review. Changes and interventions can introduce additional risks, but these need not preclude functioning markets. In fact, periodic adjustments are often necessary for the long-term well being of the market. Interventions by central banks are frequent and the process is well understood by bond markets. In some tradable permit markets, especially fish quota markets, adjustments are scheduled. For example, in the successful New Zealand fisheries management program, individuals hold long-terms claims on a portion of the annual catch rather than a weight-denominated quota. Decisions on the total catch are made annually. This introduces variability in volumes and income, but adds to the long-run sustainability of the program.

Monitoring

The success of emission reducing programs can only be established through monitoring and reporting. The US Acid Rain program's emission permit trading component is widely viewed as a successful way of lowering costs and enabling emission reductions. Initially, many in the press and the environmental community were skeptical. Monitoring results established the positive environmental effects of the program early and falling permit prices gave evidence to lower-than-expected costs.

Monitoring can be difficult and expensive. The US Acid Rain program and the RECLAIM program rely on continuous monitoring devices or frequent inspections. Moreover, successful monitoring programs, like the Acid Rain program, have to date concentrated on large fixed polluters. Monitoring multiple, moving fishermen has proved more difficult. In New Zealand, the government employs satellite pictures, informants, and on-board inspectors.

Quality control and dispute resolution

In commodity markets, the desire for long-standing business encourages firms to manage quality-- that is, to make certain the product they sell is the product they claim it is. Carbon credits however derive their value through the certification process, so quality control issues relating to certification become more crucial. Carbon credit buyers will insist on valid certification, but may not directly care about the environmental impact of the project. Establishing who is responsible for the performance of the certifier will fundamentally affect the incentives for quality control and also the riskiness of purchases. As discussed later, this is potentially one source of heterogeneity among credits.

Information about quality tends to be held asymmetrically -- producers are more likely to know about the quality of their product than buyers. However, establishing quality through inspection, sampling or other means before contracting purchases is expensive and time consuming. In addition, such procedures would preclude forward purchases. As a result, industry participants in most established commodity markets have worked out explicit rules to resolve disputes concerning arbitration and compensation. Still, delays can prove costly even for parties that eventually win arbitrated disputes. To avoid delays, several organized futures exchanges, like the Chicago Board of Trade, take on the responsibility of guaranteeing quality and other performance characteristics of its trading members. Buyers and sellers deal with the exchange, not with each other, thereby eliminating all counter-party risk. In turn, the exchange manages its own exposure to *performance risk* through margin requirements and other techniques. Given the right conditions, private markets for performance risk in carbon credits may emerge as well.

Standardization, reporting and banking

In the carbon credit markets, as in all markets, both supply and demand will contain elements of uncertainty. Credits may not be produced as expected, or delivered late. The expected need for credits may differ from actual need. Problems associated with surpluses or shortfalls can be minimized if markets are liquid; that is, if it is easy to buy and sell credits as the need arises.

Standardizing, or homogenizing the credit has been crucial in other permit markets. For example, the US SO_2 permit market is national and increasingly liquid because emission permits are distinguished only by vintage. For some pollutants, location does matter and markets must be segmented. For example, the RECLAIM program distinguishes between in-land and coastal sources since these have different smog-generated characteristics. Carbon emissions do not have local effects and are well suited for a global market.[22]

The Kyoto protocol and other proposals[23] appear to provide a mechanism for standardizing credits. Under the Kyoto Protocol's Article 12, the Conference of the Parties would provide guidelines for establishing and verifying joint implementation reductions and designate "operational" entities to certify the reductions. Once certified, acquired credits can be used to "assist in achieving compliance in the first commitment period." Potentially, this mechanisms can

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[22] It should be pointed out that climate control agreements don't necessarily have to standardize credits for markets to function effectively. In many markets, intermediating instruments frequently emerge to combine heterogeneous goods into a more homogeneous product. For example, debt from thousands of individual credit card accounts, assets from a bank's perspective, are often pooled and sold on secondary markets. Even heterogeneous real estate assets can be bundled -- often in dividend-paying trusts -- and sold on security markets.

[23] For example, see UNCTAD, 1996.

jointly perform two key functions to facilitate secondary markets. The process can standardize credits through the certification process, and can also establish a reporting mechanism that reduces trades in bogus certificates, and provides valuable market information to buyers and sellers.

Lessons from the US SO_2 and earlier lead phase out programs are relevant. The US EPA had little experience in permit trading when the lead program was launched. EPA failed to provide a certification mechanism for created surplus allowances and some refiners produced bogus allowances for sale as prices rose. Computer systems were inadequate as the number of gasoline blenders rose. The EPA faced a backlog in reviewing reported lead rights data and tracking potential violators proved labor intensive. When the more ambitious Acid Rain SO_2 trading program was launched, extensive resources were put into the registration of trades through the EPA's Allowance Tracking System (ATS). Under the program, there are no restrictions on who can buy and sell allowances; however trades must be registered ex post with the EPA by authorized representatives. Firms can designate their own representative directly, or trade through a broker. An average trade registration is completed in 30 minutes and all trades are registered within 24 hours. Moreover, the trading data are made available to the public through a Web site. Similarly, in California SCAQMD set up a computer bulletin board for posting trade requests for the RECLAIM program.

The ATS system brings several benefits to the secondary market. First it makes available to the public past allocations and trades of permits in a transparent way, generating confidence and easing the task of establishing ownership. Second, it provides the market place with information on trading volumes in a timely fashion, allowing participants to judge liquidity.

Inventories can provide an additional inter-temporal liquidity to markets. The relationship between market prices and storage is well studied in commodity markets and experiences in commodity markets have been repeated in recent permit trading schemes that allow users to save or "bank" permits[24]. Inventories of permits can be held to meet unanticipated needs and inventories allow users to smooth anticipated price changes. Analysts of permit markets have not always appreciated this fact. For example, early simulations of the RECLAIM program in the LA basin anticipated sharply rising permit prices as emission limits grew more stringent. The program allowed banking however, and firms chose to purchase and hold early vintage permits for future use. Similar experiences were recorded in the US lead phasedown program and the US SO_2 permit market.

A secondary positive benefit of "banking" permits in cap-and-trade systems is that the practice tends to encourage early reductions. As noted earlier, emission bindings tend to start lax and tighten over time. Anticipating higher future permit prices, firms tend to purchase and hold permits of an early vintage for future use. Consequently, emission reductions take place earlier than required. Since the permits are used later, total reductions over time are unchanged; however, when the effects of pollution are cumulative, the net effect can be positive for the environment.

Destination market sovereign risks.

As discussed earlier, domestic policies shape the markets and incentives for using credits. Firms with domestic obligations to reduce emissions have few choices to offset risks associated

[24] For examples from commodity markets, see Working (1934), Williams and Wright (1991) and Larson (1994).

with changes in obligations or policies specifying the manner in which the obligations can be met. Still, policy makers can take steps to implement domestic policies to mitigate risks to domestic firms by adopting clear policies that cover a period consistent with long-term investment decisions. Examples of such policies include the RECLAIM and SO_2 programs. A different approach with the same goal in mind is taken in the case of the Dutch Covenants and similar voluntary agreements in Denmark and Germany, where obligated firms have a measure of control in collectively establish how program goals are accomplished.

Many firms, especially those engaged in power generations are subject to regulatory oversight by local, state and federal authorities. Sometimes this can create an overlapping and complicated set of incentives that work in unexpected ways. In the US, economists have argued that the way electricity rates are set by regional commissions creates incentives for capital-intensive rather than cost-minimizing solutions to SO_2 emissions. In other examples taken from the US SO_2 program, additional requirements by local authorities to use domestic coal or to use a particular technology has also reduced the cost-savings to firms from the federal emission-trading program. Policy makers need to be vigilant in order to guard against counter-productive regulation.

As with the general agreement, domestic policy makers also need to consider how markets related to carbon credits may evolve. This is especially important in countries where the power sector is undergoing privatization and electricity markets are opened to competition. Cap-and-trade programs like the US SO_2 markets function well as national electricity markets are deregulated. In the absence of additional regional regulations, the cost of acquiring the right to emit SO_2 is uniform nationally so the program does not generate artificially incentives to produce electricity in a particular location. At the same time, it does encourage the use of production technologies that reduce or eliminate SO_2 emissions. Opening the US market to *international* markets for electricity however would require a modification of the program -- for example a requirement that electricity imports be matched with emission permits.

Host country risks

As mentioned earlier, investors face a set of risks stemming from the policies of the country hosting the joint implementation project. Sometimes, the risks can originate with earlier bilateral or multilateral agreements.[25] Still, such risks are not unique to joint implementation projects, and risk management lessons can be drawn from other types of investment.

Pooling and risk sharing

A number of smaller scale investments can be pooled to limit the effect of policy changes in a single country on overall returns. Large companies, for example Enron in energy or Tate and Lyle in sugar, have multiple investments in many countries creating a portfolio of projects with different country risks on their own company balance sheet. Smaller investors may choose to participate through a mutual fund, for example buying into a pool of commercial loans. Portfolio managers may actively manage the fund on behalf of investors. Companies, especially commercial banks, may choose to share risks though project financing. Under such arrangement a lead bank will put together financing from many institutions to fund a single large project.

[25] For example, Finland was unable to apply a carbon-tax to imported energy because of EU free-trade agreements.

Sovereign risk insurance

Certain types of policy risks, for example appropriation or currency convertibility can be insured. Providers include private sector companies such as Lloyds of London, American Insurance Group and Citicorp International Trade Indemnity. Many countries will also provide credit and political risk insurance for exporters. Examples include HERMES in Germany, the US Export-Import Bank and MITI in Japan. Multilateral development agencies, including the World Bank Group, the European Bank for Reconstruction and Development, and the Inter-American Development Bank also provide varying degrees of coverage. However, insurance against policy changes is rare. A few government agencies offer comprehensive insurance that would cover losses regardless of cause, but this type of insurance is not accessible to most investors. The World Bank offers coverage against a pre-defined list of government actions, but will only do so with host government participation.

Project risks

Handling project risk is standard fair for the international investment community. Pooling and risk-sharing methods that apply to country risk also apply to project risks. In addition, investors undertake a variety of precautionary actions collectively referred to as due diligence. Engineers, accountants and market experts are frequently consulted to limit risks associated with the project. While carbon credit markets have yet to fully emerge, many of the underlying technical skills in engineering, permit trading and project evaluation exist in either related markets – for example, regional markets for emission reduction credits in the United States—or from experience gained under experimental joint implementation programs.

Price risks and secondary markets

Prices may be volatile for the underlying product of a joint implementation – for example the price of electricity – as well as the price of the credit itself. Markets for handling price risk associated with currencies, interest rates and a variety of commodity markets have emerged. In the case of SO_2 permit markets, the Chicago Board of Trade announced plans to launch a futures contract and over-the-counter option markets have emerged. In California, two private firms broker many of the RECLAIM trades.

As argued earlier, the need for secondary markets and the volume of trades will be determined by a combination of policies. In the Kyoto Protocol, the Clean Development Mechanism can play an important role in homogenizing credits. Such standardization will facilitate liquid and low-transaction cost markets. Still, domestic policies will also determine final demand for credits, as well as the demand for related risk management and derivative products. Price risk management is especially relevant under cap-and-trade schemes and for joint implementation projects that sell credits into volatile markets. Several relevant lessons can be drawn from other tradable permit markets.

First, the market for a stream of credits is different from the market for credits. An analogy can be drawn from the New Zealand fish quota market. There, fisherman distinguish between the rights to a portion of this year's catch and the right to annually receive a share of the annual catch. Originally, policy makers did not directly address this distinction, although a market solution emerged through leasing arrangements. Likewise, host countries will do well ensure that local rules and regulations facilitate both the market for credits and the market for credit-generating assets.

Second, information used to track credit trades is valued by market participants and is an important component of transaction costs. The SO_2 ATS system is one good example of how governments can facilitate secondary markets by quickly disseminating information. Moreover, studies of both the RECLAIM and SO_2 programs show that transaction costs fall as information about credit trades – especially price information – becomes available to market participants.

Third, private markets will emerge to facilitate trade. Indeed, in the case of the SO_2 program, poor design of the auction mechanism and the omission of pricing information in the ATS system left market participants scrambling for ways of pricing their trades. Private brokers emerged who now provide pricing information publicly via the Internet and who provide price-risk management instruments.

Summary results

Experience from other tradable permit schemes demonstrates that programs can be successful in internalizing externalities and motivating investment. Where appropriate, "banking" provisions can provide early reductions in emissions and stabilize prices. By setting firm goals, by enabling credit trading, and by providing a mechanism to certify and track emission reduction units generated through joint implementation, the Kyoto Protocol can potentially provide key elements to a successful program and an active secondary market. As with all tradable permit schemes, the institutions charged with enforcing and monitoring the program will in large part determine the success of the program.

Technical issues relating to baselining will prove especially difficult to resolve, especially where host countries do not face emission limits, and will constitute an unusual type of risk. Still, many of the other market risks associated with project development or host country risk are not significantly different from risks managed in other economic endeavors. Further, in several of the tradable permit programs active secondary markets have evolved to facilitate risk management. Pooling, due diligence, insurance and price-risk instruments are all relevant solutions to some of the risks faced by investors.

The larger issue facing investors relates to the political economy of the agreement. Lessons from failed commodity agreements and an unpopular fish quota program in Iceland point to the need to include all important stakeholders. Bringing developing countries into the agreement in a way that is beneficial to all participants will be important to the long-term success of the program

Experience from air-quality programs demonstrates that layers of regulation and varying incentives can work at cross-purposes and raise the cost of abatement -- even under cap-and-trade regimes. Companies surveyed expect future domestic regimes to reflect current regimes that differ substantially among countries. As countries move to implement the provisions of the Kyoto Agreement, policy makers should bear in mind that a patchwork of national policies or framework arrangements that fragment markets and create dissimilar incentives will: 1) increase the cost of global emission reductions; 2) generate leakages, inefficient resource use and other trade-related distortions; and 3) eventually erode support for the framework agreement.

Figure 1: Marketing chain for carbon credits

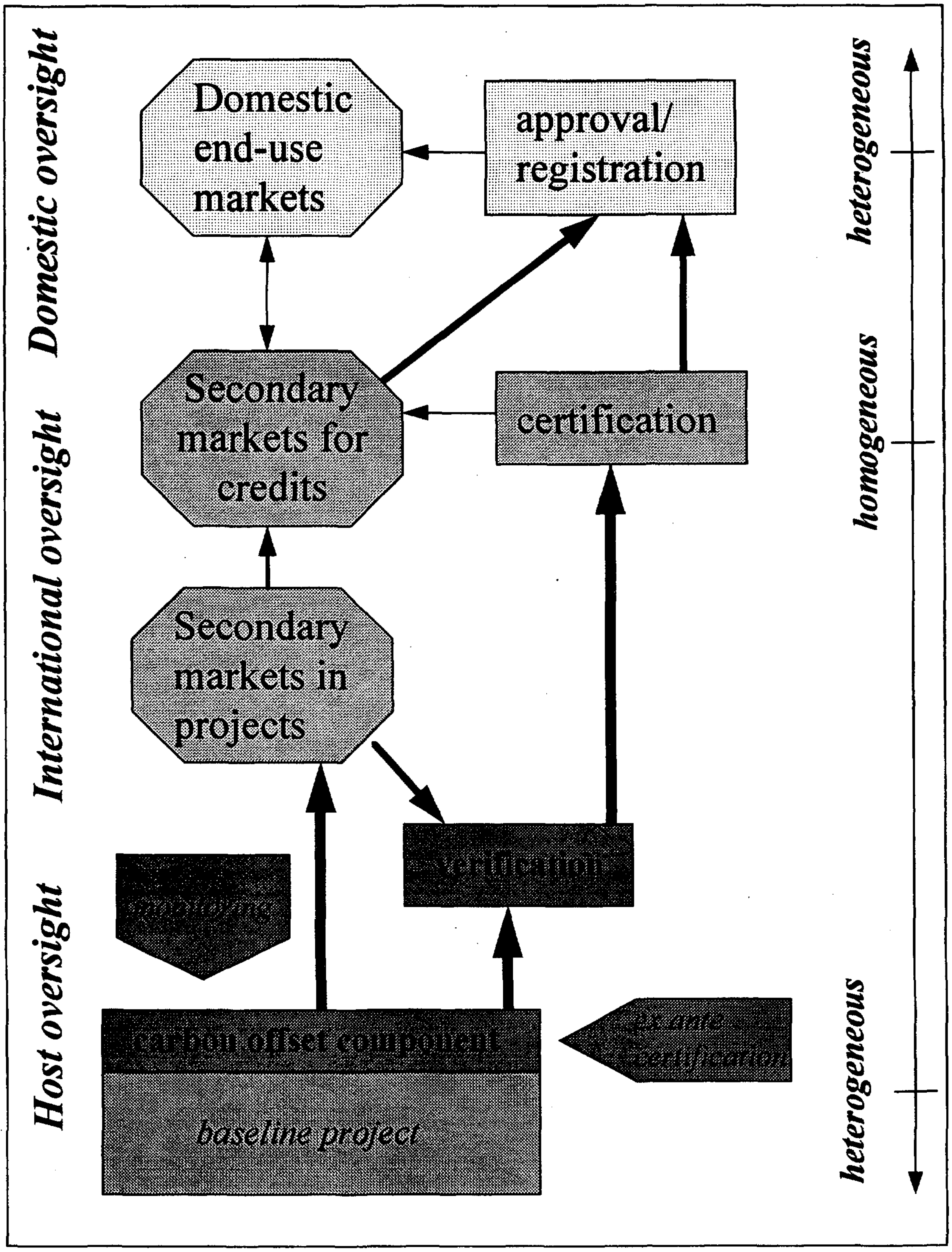


Figure 2: Cap-and-trade domestic market for credits.

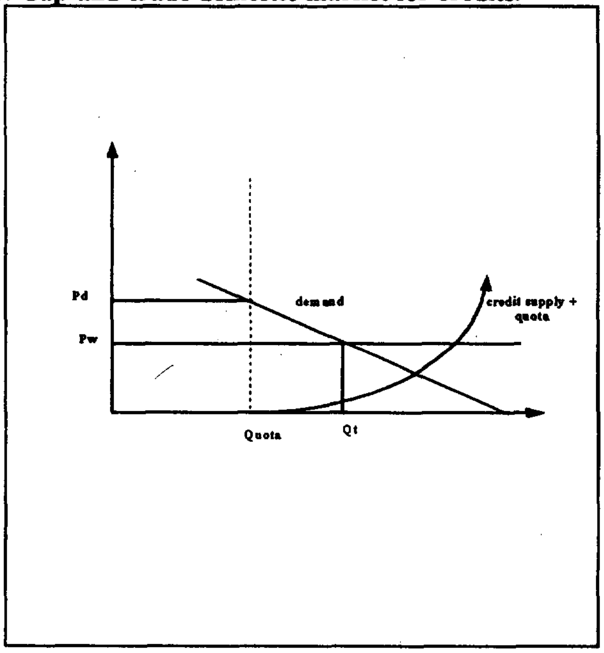


Figure 3: Carbon-tax and the domestic credit market.

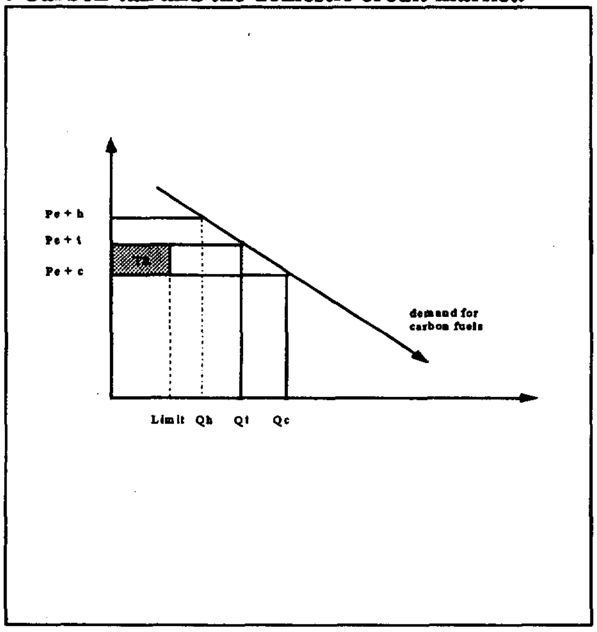


Figure 4: Alternative domestic markets for central-control countries

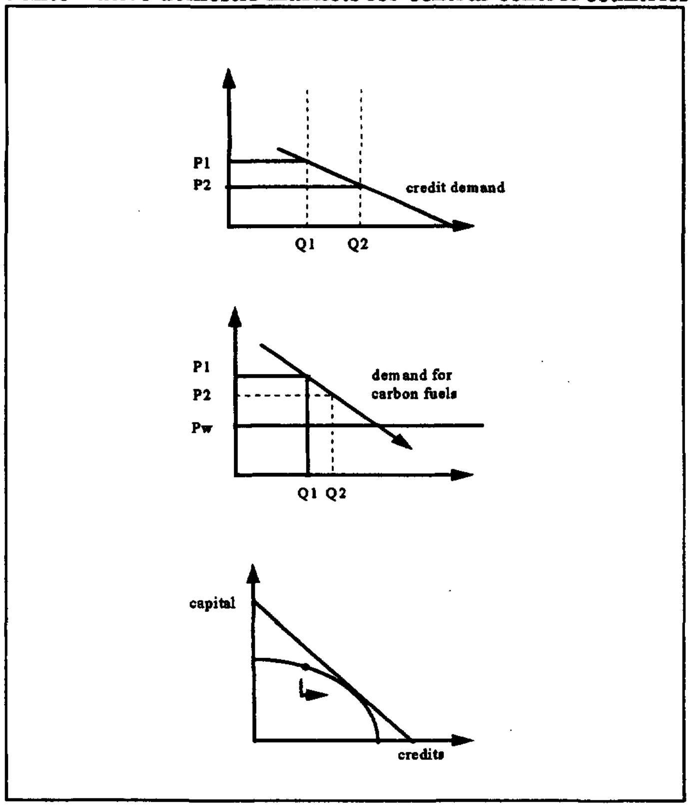


Table 1: Pricing features of alternative policies affecting the use of carbon credits.

System	domestic and international price equal	domestic price volatility	private incentives for JI
Cap-and-trade	yes	yes	yes
Carbon tax			
unlimited substitution	maybe[1]	maybe[1]	maybe[1]
limited substitution	no	no	maybe[1]
Command-and-control	no	maybe[2]	maybe[2]

[1] when the cost of carbon credits is less than the carbon tax.

[2] several possible outcomes.

Table 2: Likely sources of risk in the carbon credit market, by category.

	private performance risk			price risk			sovereign or policy risk		
	host	international	destination	host	international	destination	host	international	destination
Project preparation	x						x	x	x
Project life									
economic performance	x			x	x	x	x		
emission performance									
Validation	x						x	x	x
Accreditation	x						x	x	x
Secondary markets	x	x	x	x	x	x	x	x	x
Destination market			x		x	x		x	x

III. A Survey of Key Actors

Introduction

Selected policy makers and potential market participants were surveyed from November 1997 to February 1998 about their expectations concerning future carbon credit markets, the policies that might shape those markets and the risks associated with participating in carbon credit markets. This section of the paper discusses the results of that survey. The core survey group includes companies and governments that expressed a written interest in the World Bank's proposed Prototype Carbon Fund, but also includes other potential users of carbon-credit instruments-- for example, companies and business associations active on JI issues. Many of the organizations, both private and government, are in the forefront of the JI and carbon trading issues and will be market shapers and leaders.

The survey revealed viewpoints that are in flux. All organizations contacted stressed they were in the early stages of the planning greenhouse gas strategies and that many unresolved policy issues would influence future actions. Principle uncertainties mentioned were the lack of framework conditions at the international, regional and country levels unresolved technical questions such as project baseline determination procedures. Consequently, future events could fundamentally alter these perceptions and the preliminary nature of these responses should be stressed.

About the survey

Respondents

The survey targeted individuals familiar with greenhouse gas issues who also play a role in determining climate change strategy on behalf of their organization. The entities selected included many potential participants in the World Bank's Prototype Carbon Fund; companies and organizations that had made public statements concerning greenhouse gas issues; and others active in the policy debate. As a result, the respondents constitute a small focus group of knowledgeable and interested parties rather than a scientific sample of opinion.

Almost all respondents reported holding internal discussions concerning greenhouse gas issues. In addition, respondents working for organization which are large emitters of greenhouse gases reported that their organization had made attempts to quantify those emissions[26]. Of that group, some had also attempted preliminary estimates of abatement costs. One of the companies had begun developing an internal simulation on carbon trading. The respondents' awareness of joint implementation issues was high. Several had attended the Kyoto conference and several were participating in joint implementation activities. Nevertheless, the respondents conveyed a strong sense that the international and domestic policies related to joint implementation and carbon-credit markets were still evolving. By implication, the respondents' views toward anticipated markets and perceived risks are evolving as well.

[26] Generally, the estimates were for carbon emissions from fuel consumption.

The sample comprises eighteen European companies and business federations; five North American companies; five European governments; two European non-government organizations; and one Japanese utility. Most of the companies surveyed are major emitters of greenhouse gases (mainly carbon dioxide) and several are large, energy companies. The energy companies include major international integrated energy companies, electricity producers, and gas transmission and distribution companies. After energy companies, large industrial companies-- mostly large construction and metal producers – were the largest cohort. Business federations active on behalf of their membership on environmental matters were included as well. A small number of financial service companies -- primarily insurers and brokers-- and renewable energy producers were surveyed as well. Five European governments were surveyed, all of which have indicated interest in the World Bank's Prototype Carbon Fund. Therefore the government respondents represents a somewhat self-selecting group active in the climate change debate that see joint implementation as potentially useful.

Structure of the questionnaire

The questionnaire consisted 21 questions organized into six sets. Some questions had multiple sections so that the total number of possible responses was 40.[27] The first section of the questionnaire asked the respondent about her: knowledge of greenhouse gas issues, views about policy regimes, and perception of the role of joint implementation. The second and principal section focused on the perception of the risks involved in the joint implementation process and subsequent secondary markets. The risks were subdivided into project risk associated with 1) changes in regimes that could impact the transfer or value of the project's carbon credits and 2) the project's technical and cost performance in reducing greenhouse gas emissions and risks associated with the structure, liquidity, and transparency of markets for carbon credits and carbon-based instruments. A final section looked at the potential role of a carbon fund in mitigating perceived project and market risks. To allow comparability between respondents, the questions could generally be answered by yes or no; or by ranking (very high, high, medium, and low.) A few questions required other responses such as geographical preference for joint implementation.

Domestic greenhouse gas regimes

In this context, domestic regimes are the policies adopted by Annex 1 countries that determine how carbon credits can be used. Respondents were asked to rank the likelihood of the three domestic policy regimes described in Section I. The choices were not exclusive, since a country can have a mix of measures and an organization can operate in multiple countries, facing multiple regimes.

Of the three potential regimes, European[28] companies[29] ranked the regulation and carbon tax regimes as most likely. Indeed these two approaches seemed linked, with companies believing that domestic regimes could well include both types of measures in its greenhouse gas policies. (Figure 5) In interviews, almost all European companies were familiar with the US sulfur dioxide emission trading program and found the results significant. Nevertheless very few European

[27] A copy of the survey instrument is available from the authors.

[28] In all cases, the grouping on European companies includes the response of one Japanese utility.

[29] Unless stated otherwise, companies also includes business organizations.

companies thought cap-and-trade regimes had a high chance of being a major component of European emissions policy.

Contrary to the European responses, the North American companies ranked cap-and-trade as the most likely option followed by regulatory. Carbon taxes were considered the least likely. Such a response seems in line with the existing North American environmental and regulatory context that has traditionally relied on strong regulatory regimes but has recently moved more to economic instruments such as cap-and-trade. The European companies that thought cap-and - trade could play a major role, almost all were UK based which perhaps share a view more similar to those in North America.

Despite variances in the type of regime, most companies believed that they would be required to take direct action due to greenhouse gas policies and measures. Among the European countries, a widespread view was that voluntary agreements would be a major means of coordinating and implementing greenhouse gas reductions. This view is also based on the prevalent use of such agreements in Europe. Interestingly, while lacking a history of voluntary agreements, some North American companies also viewed such agreements as useful in the carbon reduction context.

Generally however, companies, regardless of location, expected the government policy makers to continue current approaches. Consequently, to some degree the fact that many companies covered by the survey anticipate carbon-tax and regulatory approaches reflects the composition of the survey sample.

European government responses

Interestingly, European governments appear more willing to utilize market-based tools (carbon taxes and cap-and-trade) than European companies believe them to be. For example, EU governments ranked regulatory regimes as a low to medium option as opposed to the much higher probability assigned by companies. Further several companies headquartered and with major operations in one country ranked the probability of a regulatory regime as high while the government itself ranked it as low.

On cap-and-trade regimes, governments also gave this a higher probability than companies by and large did. Governments generally stated that such a measure was possible -- presumably as a part of an integrated policy. Again companies located in that country, gave this option a lower probability than the government, itself. The governments viewed the probability of carbon taxes as high, but then again several of the governments surveyed already have such taxes. Therefore expanding this result to countries without current carbon taxes could show a different result All governments surveyed saw a role for voluntary agreements in the implementation of domestic regimes.

Utilization of joint implementation

Overview

All large carbon emitters surveyed expressed a willingness to use joint implementation. Indeed in interviews, some expressed a belief that joint implementation would be a major tool for achieving greenhouse gas reductions. The questionnaire offered four approaches to joint implementation:

- generate credits with self-managed projects internal to the organization-- that is, using carbon reductions in company operations in one country to offset domestic carbon requirements in another;[30]
- manage new projects with independent host-country partners;
- actively managed a pool of joint implementation projects backed by multiple participants and;
- passively invest in joint implementation projects managed by others.

Company responses

Companies showed a clear preference for directly managing their joint implementation investments. (Figure 6). This preference cut across company types, with the only exceptions being some domestic electrical utilities. The first approach -- internal joint implementation projects-- was the overwhelming favorite of those companies with significant international operations. All such companies ranked this option as high or very high. In interviews, these companies saw clear economic and operational advantages to such a strategy. The economic benefits from joint implementation often result in energy efficiency improvements that the company believed would yield economic benefits for its own operations.[31] Operationally the large international companies saw internal joint implementation projects as relatively similar to existing operations and could be integrated into current capital investment strategies. Monitoring of internal joint implementation projects was also thought to be easier.

Large, international companies that ranked the first approach highly, clearly preferred it to the other options. Related to this, in interviews some companies often expressed a clear preference to controlling the joint implementation projects. This viewpoint is not surprising given the large size of these companies that are clearly used to running their own operations. In contrast, large companies whose operations are primarily in one country (generally domestic utilities), by necessity, ranked internally managed projects much lower since they lack the international operations to implement this option.

Several of the companies showed a geographical preference for joint implementation projects relatively close to their existing operations. The more international the operations of a company, the more global their geographical interest.

European government respondents

In general, governments showed more uncertainty as to ranking these options and often responded that they were still discussing how to implement joint implementation. They were more positive about being passive participants in a portfolio; reflecting their more limited operational capacity. An issue frequently cited was that until EU policy was clarified, domestic joint implementation policy could not fully evolve for member countries. Geographically, several of the governments cited a preference for Central and Eastern Europe and the Baltic. Given the location

[30] Given the nature of government options, the first option was modified to "concentrating on projects sponsored by domestic corporations."

[31] These economic benefits would presumably be less than the cost of the JI investment, and thus would be implemented only with the financial benefits of carbon credits. However the definition of additionality is still undecided.

of the respondent countries, this preference indicates a desire to pursue joint implementation projects in nearby countries.

Performance and sovereign risk

A distinction was made between performance and sovereign risks in order to separate the technical risks from the policy changes that can impact carbon credits. Both of these types of risks can influence joint implementation investment decisions by affecting the risk premium required for investment and the discount value-- especially if risks are believed to change over time.

Project risks

Project risk has two basic components: the ability of a joint implementation project to meet the projected improvement in carbon emissions and the accuracy of the technical cost estimates. Additional risks concern the over-time performance of the facility and the acceptability of monitoring and verification procedures.

The cost parameters are primarily the initial investment and the operating costs. Variations from planned carbon reductions directly impact the cost/ton. Further joint implementation projects based on switching to less carbon intensive fuels (e.g. coal to gas) are exposed to changes in fuel prices affecting the competitive advantage and thus the project's financial status.

European companies rated the risks of both achieving the greenhouse gas targets and the cost per ton to have, on average, slightly above medium risk. (Figure 7) Perhaps reflecting their linkage, both the emissions and cost variables were considered to have about the same level of risks. Companies with primarily domestic operations tended to consider the risks higher than international companies. This could be a response to their overall lack of experience in international projects, rather than the joint implementation nature of the project. In interviews with companies, this risk was generally not thought to be substantial. The five North American companies saw these risks at approximately the same level as the European companies. However a substantial difference exists between the North American financial companies that tended to view these risks in the low to medium range, while the energy companies rated them in the high range.

Governments were often uncertain as to the risks – perhaps because they are not traditional international investors. Even with countries with substantial joint implementation experience, there was wide disparity of the perception of risk related to greenhouse gas reductions and costs. Other countries reported they had too little information to respond or that the issue was too project specific for generalization.

Sovereign risks

Company respondents

Changes in host government regimes (where the JI project is located) were considered the greatest risk, and indeed, the highest single risk by companies in the entire survey. (Figure 8) Both large and small as well as international and domestic based companies ranked this as high to very high risk. Even companies that presumably could mitigate such risk, for example international companies with a preference for internal joint implementation projects, still considered the risk high. In interviews, when the issue of joint implementation investments was discussed in terms of how investments would probably concentrate in countries with a perceived lower sovereign risk, interviewees, while agreeing to this, still found the risk high.

Domestic government risk (where the carbon credits are utilized) was perceived as much lower, albeit about one third still found the risk high. In interviews, the risk associated with domestic regimes was less one of changes once the regime was in place; but uncertainty as to the design of the policy itself. This uncertainty was further accented by how EU policy would affect domestic policy. Consequently, a distinction should be made between the risks associated with host governments where detrimental changes in regimes were considered possible, and domestic regimes were the risk was tied more to the uncertainty of the regime's initial design.

The level of risks associated with international accords fell between that of host and domestic regimes. On an overall basis, the risks associated with the international accords were relatively high, and associated with the lack of definition of many of the joint implementation issues. For example, several companies mentioned their confusion concerning the "clean development mechanism" introduced in Kyoto.

European and North American companies responses were quite similar in ranking host government risk higher than that of the domestic government. However, North American companies viewed the risks associated with international accords much higher than their European counterparts.

European government respondents

Interestingly governments rated sovereign risk much lower than companies. Even host government risk was considered low to medium -- albeit one stated this was done by carefully selecting the host country. One qualification made by two governments was that Annex 1 countries represented lower risk than non-Annex 1, especially given the uncertainties of the "clean development mechanism." Not surprisingly, domestic governments rated domestic government risks as low. Legal restrictions were mentioned as limiting changes in polices and measures. The main issue was thought to be uncertainty as to the shape of domestic policies and not changes in policies. International accords were perceived as having a greater sovereign risk than the other two categories. Here again the risk revolved around the number of uncertainties that still need to be resolved by negotiation.

Monitoring, validation and certification

At both the project and sovereign level, risk is associated with the monitoring, validation and certification of carbon credits. At the project level, poor or improper monitoring could lead to doubts as to the amount and quality of carbon credits generated by a joint implementation project. At the sovereign level, an accepted and transparent method of certifying credits is needed to assure their bilateral and international acceptance. The monitoring issue involves the determination of a baseline as well as the monitoring of actual emission levels from the joint implementation project. Several respondents brought up the *baseline issue*, and one respondent found it the most important issue in the joint implementation debate. As validation and certification has not been addressed by the conventions, how and under whose authority this will occur continues to be a major uncertainty.

Companies gave the monitoring and validation issues one of the highest levels of risk in the entire survey. This high ranking was given across the range of companies. (Figure 9) Governments as well assigned very high to medium risk levels for this category.

Secondary markets

Overview

Both companies and governments almost universally recognized the utility of a secondary market. Indeed some companies considered it essential and doubted that carbon credits could fully develop without it. The major uncertainty was the timing of the market's development with several respondents thinking it could take several years. Some entities thought that a secondary market in the US was more likely than in Europe. Companies generally believed that domestic governments would introduce policies to support the development of a secondary market.

In stark contrast, only one government thought domestic policy support for secondary markets was very probable; others thought it too early to predict such a choice. Governments were also attuned to the need to balance policies and brought up concerns about need to harmonize with other actors and the need for policies to encourage domestic physical reductions as well as trading in credits.

The differences between government and company approaches to the secondary market were also shown by the interest in futures markets and reserve prices and auctions. While most companies expect futures and options' markets to develop (albeit with differences on when) governments seem less certain this will occur. Further on the issue of reserve prices or auctions to reduce some of the secondary market risks, companies were generally negative or indifferent while governments generally saw them as useful.

Types of market risk

Secondary market risk was divided into seven categories dealing with market structure, price information, and liquidity. Respondents ranked these categories as to very high, high, medium and low. The specific categories were:

- heterogeneity (differences) among carbon credits as to their perceived risk and trading characteristics;
- the lack, especially in the beginning, of an organized market for carbon credits;
- counterparty risks associated with the buyer or seller's ability or willingness to fulfill their commitment;
- limited price information on market trades;
- dominance of the market by a few players;
- limited number of market participants;
- low market liquidity.

European company respondents

Companies ranked the possibility of *heterogeneity among carbon credits* as the greatest market risk. Almost two thirds of companies rated this risk either very high or high, and was the only question in the survey that no company ranked as low risk.[32] (Figure 10) Several companies mentioned the clean development mechanism as already implying a difference between Annex 1 and non-Annex 1 carbon credits.

A related issue is the bilateral certification of carbon credits between the host and domestic governments which presumably requires that carbon credits for any specific joint implementation project be traded only within the signatory domestic country. Such a condition reduces the size of the secondary market by limiting the area in which any specific certificate can trade.

Companies rated the *lack of an organized market* as the second highest risk. Half of all companies ranked this a high to very high risk while a third ranked it as medium risk. This concern is linked to the belief that most companies see a secondary market as key to the trading of carbon credits and thus its absence would be a major barrier to trading. It should be noted, however, that several of the larger companies ranked this risk as low in that they were confident that such a market would develop if needed.

While the remaining five categories received fewer rankings of high risks, all except one were considered to have substantial risk. *Counter party risk* was considered substantial. One third of companies ranked this as very high to high risk and more than a third as medium. The counter party risks were seen to be related to potential changes by host countries and the long-term nature of joint implementation projects that could increase the risk of future delivery of carbon credits.

The remaining four categories can be viewed as relating to the viability of the market itself – specifically if the market will attract enough players and trading to provide sufficient price information and trading depth. *Limited price information* and *market dominance* were considered a high risk by one third of companies. These two categories are closely linked in that market dominance by a few players could be seen as reducing price transparency. Almost all companies that ranked market dominance as a high risk also linked price information as a high risk as well. The converse was also true that companies that considered one a low risk considered the other low as well.

The risk categories of *lack of liquidity* and the *number of participants* were also linked by companies, albeit not as closely as price information and market dominance. The relation between liquidity and number of participants is intuitively obvious and most companies tended to rank their risk equally. In some cases the risk diverged. One company thought that there could be a high number of participants but still that liquidity would be determined, and perhaps limited, by a few large players.

One important point is that companies had different types of risk profiles overall -- i.e. companies tended to either rank most of the seven risk categories as low or as high. Only a few companies had significant variances among responses. Interestingly these variations in risk profiles do not appear to be particularly related to either company size or sector.

North American company respondents

North American companies also found the secondary market risks substantial, and the general risk profile was broadly similar. Lack of liquidity and heterogeneity of the credits was considered the highest risks followed by lack of an organized market and counterparty risks.

[32] This risk was also reflected in the high risk that companies gave to the monitoring and certifying carbon credits.

Energy companies seem to have consistent risk profiles across the categories – i.e. assigning all categories the same level of risk. This was not true of the financial companies that saw differences in risk across the categories. Notably, the energy company that saw the highest secondary market risk, also stated that its preference for bilateral and lateral trades, thus avoiding the market to the extent possible.

European government respondents

The five governments surveyed ranked the secondary market risks much higher than companies did. Indeed higher risk was perceived across all seven categories, except curiously, the companies concern about the heterogeneity of credits (their highest risk) was ranked lower by governments. While the small size of the sample makes generalization difficult, the risk levels showed little variation. All seven categories received rankings between high and medium and no country ranked the risks as low. One country did not feel it had sufficient information to rank most of the risks.

One reading of this result is that while some European governments see secondary markets as useful and desirable, they also perceive them as carrying substantial risks. Such an implication could have an impact on the evolution of domestic regulation of secondary carbon markets.

Carbon funds

Overview

In this section, respondents were asked whether a managed pool of carbon-based investments similar to the proposed World Bank Prototype Carbon Fund might be used to facilitate markets and offset risks. Related to a carbon fund, five potential risk or cost-reducing benefits arising from a fund were identified:

- lower cost per ton of carbon reductions
- decreased sovereign risks
- improved tradability of carbon certificates
- lower transaction costs
- improved price transparency.

Respondents were asked to rank them from very high to low.

Company respondents

Concerning risk minimization, European companies saw a carbon fund as having the highest benefit in reducing sovereign risks and improving tradability of certificates; moderate use in reducing transaction costs and improving price transparency; relatively little use in reducing the cost/ton of carbon credits.

The mitigation of sovereign and tradability risks is particularly significant in that companies ranked these as the highest risk variables. Among the project risk categories, companies ranked host government risk the highest; while in the secondary market risk categories, the highest risk ranking was in trading limitations due to heterogeneity among carbon credits. Therefore European companies see a carbon fund as positively affecting the two greatest risk variables identified in the survey. In interviews, sovereign risk was almost always identified with the host country. Here a multilateral bank's lending operations and financial presence was viewed as helping to insure that joint implementation agreements would be honored. Several companies believed that, joint implementation projects in some countries might only be possible in conjunction with a multilateral institution. The tradability and sovereign risk issues were connected in that companies generally saw that the quality, and thus tradability, of the certificate would often be based on the perceived reliability of the host government. Several companies suggested that projects associated with international development banks would have a lower risk associated with monitoring and certification.

The factor European companies judged least beneficial had to do with final costs. Generally, firms believed that a portfolio of joint implementation projects managed by a multilateral lending agency would be relatively high cost, and at best only marginally less expensive than could be identified elsewhere. In interviews, some companies suggested that if such funds were successful, new entrants could emerge with lower cost/ton portfolios, displacing multilateral investment pools.

The North American companies were more skeptical of a carbon fund than their European counterparts. While some companies said that such a fund could have positive benefits, especially in the beginning, one said that the overall effects would be negative. All but one of the companies thought that reducing sovereign risks would be the fund's largest benefit. However all the other categories were ranked less highly than by the Europeans, and again the perception was that such a fund would be high cost on a per ton basis. Thus in general, the North American firms sampled saw fewer benefits to a fund than the European firms.

European government respondents

Government responses varied substantially from companies but showed no consensus. On the issues that companies found most important, sovereign risk and tradability, governments were less clear. On sovereign risks, two governments found a carbon fund to have a high benefit; but three others found it unclear. While on tradability, government views of the benefits ranged from high to low with two undecided. Transaction cost benefits were ranked the highest single advantage of a fund. Price transparency was also thought to be improved. Interestingly some governments viewed a carbon fund as having a cost/ton advantage. An interesting observation is that all the governmental respondents have expressed interest in participating in a carbon fund, yet they hold very different opinions as to the advantages of such a fund.

Summary results

Greenhouse gas regimes and joint implementation options

Most respondents expected that future regimes would reflect current environmental and industrial regimes existing in their home countries. For example, most European respondents tended to think that domestic regimes would be based on regulatory and carbon tax measures. While most were familiar with the US model for "cap and trade" used to regulate sulfur dioxide emissions, most companies did not think it would play a major role. Interestingly, European governments thought "cap and trade" and carbon tax regimes more probable than companies did.

North American companies expected "cap-and-trade" or regulatory schemes, but discounted the probability of carbon taxes.

Almost all companies felt they would face future policies designed to limit carbon emissions and wanted to use joint implementation to fulfill domestic carbon obligations. Companies had a strong preference for implementing joint implementation projects either within their internal international operations, if available, or by directly investing in outside joint implementation projects. Few companies preferred investing in managed "pools". Governments were much less certain both as to whether they would use joint implementation or the form it would take.

Risks

For companies, two risks emerged as the most important: 1) the host country's ability and willingness to uphold the joint implementation agreements; and 2) the ability to trade joint-implementation-based carbon credits. The risk associated with the host country had collateral effects on other risk categories for example monitoring, certification of carbon credits, and counter party risks. Several thought that tradability could be affected by the host country origin of the credits. The tradability concern included other issues such as certification of carbon credits, liquidity of the market, different types of carbon certificates (for example if Annex 1 and non-Annex 1 credits would be equivalent) and limitations on the trade of carbon credits between Annex 1 governments. North American companies tended to have a greater belief than the Europeans that secondary markets were essential for carbon credits and would develop. European governments tended to be less concerned about risks associated with host governments, but more concerned about the risks associated with a secondary market.

Risks and a carbon fund

Opinions of companies were mixed as to the need and role of a carbon fund-type instrument. Large companies with international operations had a strong preference for implementing joint implementation projects directly and little interest in such a fund. Companies with primarily domestic operations tended to prefer direct control of joint implementation projects but had some interest in a fund type instrument. Only a few companies, primarily domestic utilities, believed that this type of instrument could be highly useful. North American companies were generally skeptical of the value of such a fund. Almost all companies though that a carbon fund would be high cost. Governments were less decided on the benefits of a carbon fund but did see some advantages concerning transaction costs and improved price transparency.

Still, a carbon fund was seen as reducing two of the secondary market risk that companies found most problematic: host country and certificate tradability. Some otherwise skeptical companies thought that working with an international finance institution might be useful in some geographical areas.

Figure 5: Domestic regimes

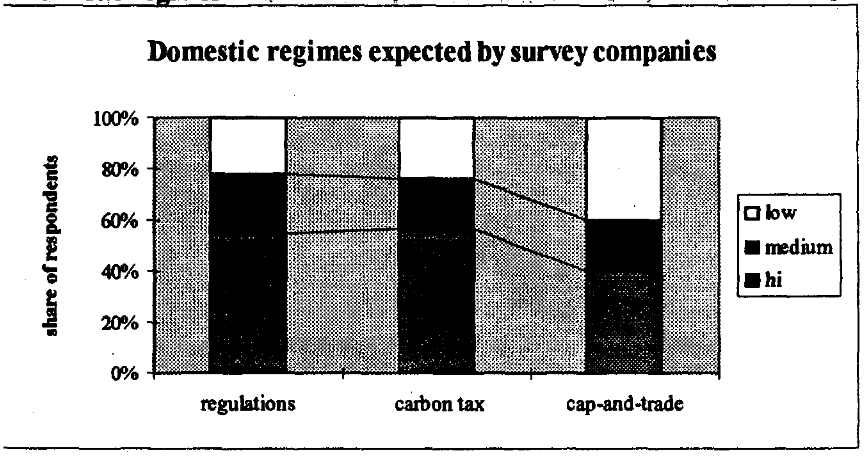


Figure 6: Preferences on management of JI

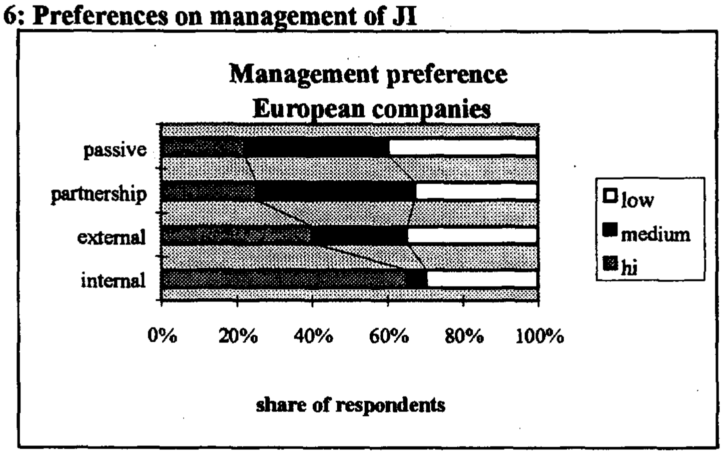


Figure 7: Perceived project risks

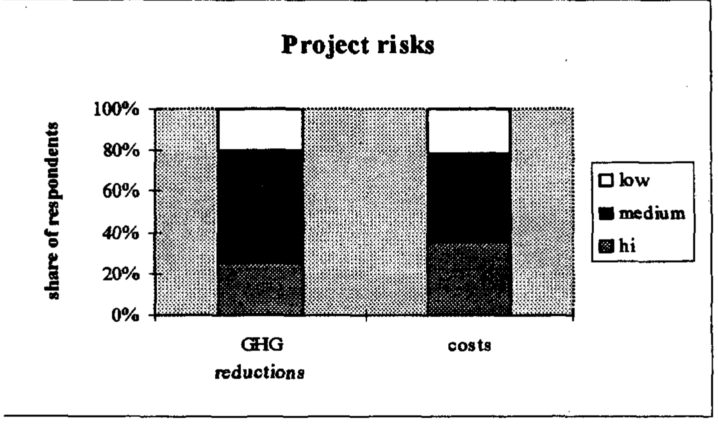


Figure 8: Policy risks

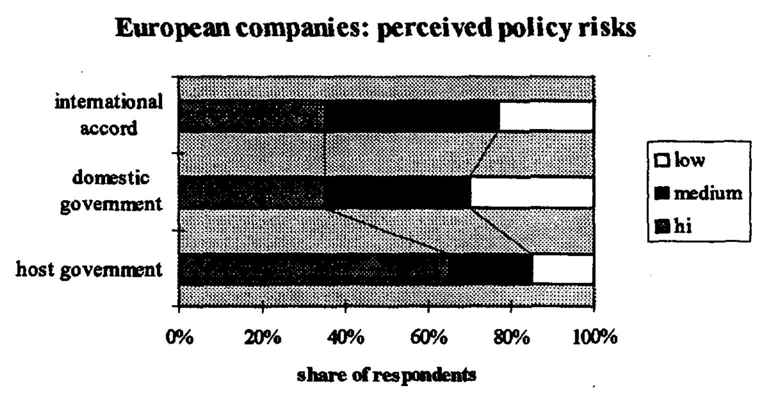


Figure 9: Certification and baseline risks

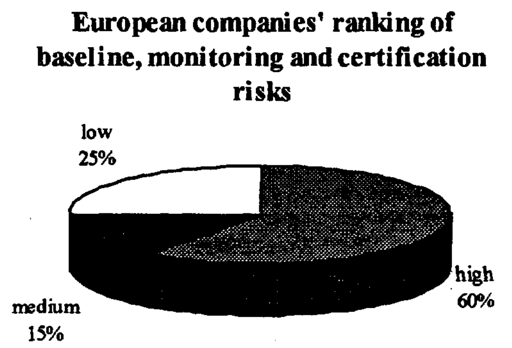
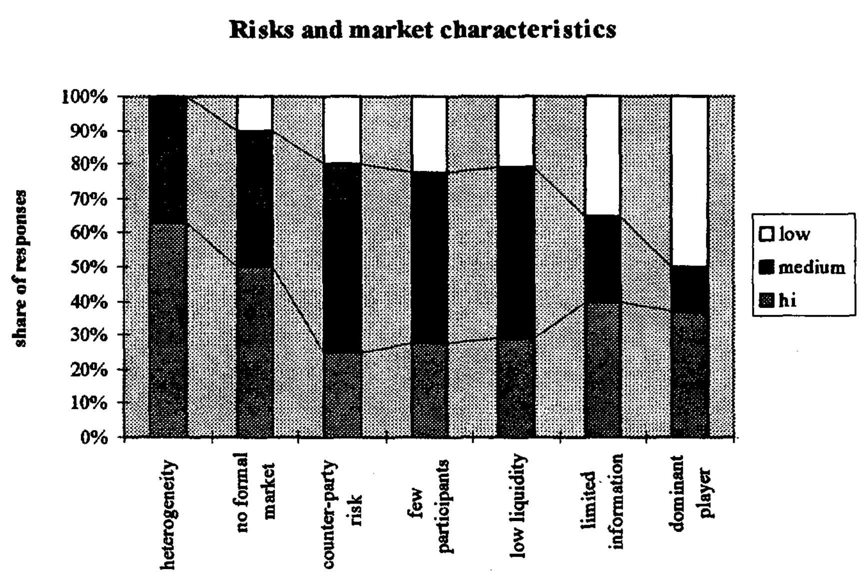


Figure 10: Market risks



IV. CONCLUSIONS

Experience from other tradable permit schemes demonstrates that programs can be successful in internalizing externalities and motivating investment. Where appropriate, "banking" provisions can provide early reductions in emissions and stabilize prices. By setting firm goals, by enabling credit trading, and by providing a mechanism to certify and track emission reduction units generated through joint implementation, the Kyoto Protocol can potentially provide key elements to a successful program and an active secondary market. As with all tradable permit schemes, the institutions charged with enforcing and monitoring the program will be vital.

Technical issues relating to baselining will prove especially difficult to resolve, especially where host countries do not face emission limits. Still, many of the other market risks associated with project development or host country risk are not significantly different from risks managed in other economic endeavors. Further, in several of the tradable permit programs active secondary markets have evolved to facilitate risk management. Pooling, due diligence, insurance and price-risk instruments are all relevant solutions to some of the risks faced by investors.

The larger issue facing investors relates to the political economy of the agreement. Lessons from failed commodity agreements and an unpopular fish quota program in Iceland point to the need to include all important stakeholders. Bringing developing countries into the agreement in a way that is beneficial to all participants will be important to the long-term success of the program. Survey results suggests that companies and governments in North America and Europe generally recognize joint implementation as key method of containing the costs of greenhouse gas regulations. Further, secondary markets are also widely viewed as important. If broadly based, these commonly held beliefs provide unifying incentives to reach agreement.

Experience from air-quality programs demonstrates that layers of regulation and varying incentives can work at cross-purposes and raise the cost of abatement -- even under cap-and-trade regimes. Companies surveyed expect future domestic regimes to reflect current regimes that differ substantially among countries. As countries move to implement the provisions of the Kyoto Agreement, policy makers should bear in mind that a patchwork of national policies or framework arrangements that fragment markets and create dissimilar incentives will: 1) increase the cost of global emission reductions; 2) generate leakages, inefficient resource use and other trade-related distortions; and 3) eventually erode support for the framework agreement.

Companies expect host-country regimes to differ and are suspicious that host governments will intervene or reverse policies. Further, they worry that the institutional arrangements for monitoring and baselining will be insufficient to guarantee results. Consequently, they expect offsets to vary in quality and markets to be heterogeneous. Institution-building and programs that address sovereign risk could reduce these risks substantially. However, governments surveyed do not view heterogeneity in offsets as a significant risk and may not place priorities on institution building.

Companies, where possible, would prefer to actively manage their own portfolio of offset projects. For surveyed companies, the primary benefit of a pooled carbon fund administered through a multilateral development institution might lie in the ability of the institution to address issues related to policy risks and transparency in the processes of baselining, monitoring and certification. Such skills are likely to be most appreciated early on when information is scarce and precedents rare. Host-country project managers may be drawn to a carbon fund for similar reasons.

Way forward

The sustained release of greenhouse gases through human activity has uncertain, but potentially severe global consequences. Similarly the cost of limiting emissions is potentially high. Significant changes in greenhouse gas emissions require broad-based changes in individual action, best and most efficiently achieved through broad-based changes in incentives. Policies that create markets where participants face artificially differentiated incentives will raise the cost of limiting greenhouse gases and erode support for, and effectiveness of, the agreement. Consequently, domestic policy makers and participants in international agreements should seek ways to limit market segmentation for carbon-credit based assets.

Experience from other tradable permit schemes shows that it is often helpful to distinguish between on-going incentives and the welfare transfers associated with establishing the initial conditions of the program -- for example, the incentive embodied with the price of an allowance, compared to the value of an initial endowment of allowances. In the same way, policy makers should try to distinguish between issues of equity and bargaining, and issues of efficiency.

Since carbon credits are rooted in policy, the institutions charged with baselining, monitoring, validation and certification of carbon credits are vital. Surveyed firms view host institutions as an important source of risk and will differentiate their investment among projects based on the perceived ability of these institutions to perform. Efforts to design the institutions to be efficient and reliable will lower the global costs of reducing greenhouse gasses.

These and related institutions can also play an important role in disseminating information essential to markets. Experience from other tradable permit schemes has shown that increased information flows and evolving markets lower transaction costs and consequently the costs of emission reductions. Further, these markets form the bases for risk management instruments.

1. Fish and individual tradable quotas: lessons from New Zealand, Iceland and elsewhere

Background

An individual transferable quota (ITQ) is a permanent right to land a specified percentage of a total annual fish catch. ITQs can be sold and are often leased as well. ITQs are usually season and species specific. New Zealand introduced the first major ITQ in 1986, but similar programs operate in Australia, Canada, Iceland, Italy, the Netherlands, South Africa and the United States.

The collapse of the Newfoundland cod fishery in the 1980s and the reduced size of other fisheries brought about a variety of regulatory systems throughout the world aimed at achieving sustainable harvests. Open systems and systems that limited the fishing season led to a "race to fish" and an over-capitalization of the industry as high-powered boats were employed to catch a larger share of a dwindling catch.

Commercial fishing rights have traded in New Zealand since 1986. The program was devised as a way to address both the over-fishing of New Zealand's in-shore fisheries and over-capitalization of the New Zealand fleet. Modification of the program are now underway. The program is generally considered successful, and has been much imitated around the world.

How the system works

Total Allowable Catch (TAC) limits are set annually by the Minister of Fisheries after consultation with stake holders --including sport fishermen and Maori customary fishers. The legislation specifies that the TAC must "move toward" a maximum sustainable yield -- providing the New Zealand government substantial leeway in setting the overall total. A portion of the TAC is set aside for commercial fishing -- the Total Allowable Commercial Catch (TACC). ITQs represent the permanent right to a specified share of the TACC. ITQs are species specific; however some minimum levels of "by-catch" are allowed.

ITQs were allocated based on the best recorded catches in two of three historic fishing years (1981-83). A Quota Appeal Authority heard over 2,000 appeals of the initial quota allocation and increased the allocation in about 1,000 cases.

ITQs are fully tradable with the following restrictions. There is a maximum quota ownership to prevent market power abuse. There are minimum quotas to limit administrative costs. Quota holders must be New Zealand residents, or companies that are 75% New Zealand.

ITQs in New Zealand can be "fished-against" or effectively leased. Beginning in 1998, fishing rights will be further delineated between the permanent quota right (ITQ) and an Annual Catch Entitlement (ACE) -- the annual tonnage implied by the ITQ for any given year. In 1998, both units are tradable. Borrowing and banking of tonnage were allowed, but these features were eliminated in 1998.

ITQs create an incentive for fishermen to both under-report and "high-grade" -- catch more than their quota and dump lower valued fish. The Ministry of Fisheries uses physical surveillance, spot checks and satellite information to enforce ITQs.

Expectations and market prices

Early on, ITQs were a new kind of commodity. Market participants were unfamiliar with the system and may have also doubted the permanence of the program. Prices for ITQs started out fairly low, but have increased in recent years. ITQs for abalone trading at NZ$ 49,500 per ton in 1988/89, but appreciated to NZ$ 210,000 by 1994/95. Hoki ITQs increased in a slightly less spectacular fashion, moving from NZ$ 2,000 in 1988/89 to NZ$ 4,500 in 1994/95.

Currently, most ITQs in New Zealand are leased rather than sold. This unanticipated market development led to the formal creation of ACEs.

Lessons from other systems

A number of other countries have experimented with similar systems. Table 3 selectively lists some fishing quota schemes. One common variant used in British Colombia, Canada and Iceland is to attach a fishing quota to a specific licensed vessel. There have also been variations on how the quota was allocated. For example, the US wreckfish quota was based 50% on historic catches, and 50% on equal shares. In Australia initial quotas for bluefin tuna were based 75% on historic catch and 25% on the value of investment in equipment.

Generally, the programs have been viewed as successful in limiting the overall catch and in reducing the capital costs. The catch is usually brought in more slowly over a longer period with fewer boats. However, the systems are not without problems. High-grading and the costs of monitoring reporting have already been mentioned. In Iceland, it is argued that the high cost of obtaining a vessel quota encourages trawling over line fishing with negative environmental impact.

A larger issue, central to all quota allocation schemes, relates to fairness. Communities dependent on fish processing feel that they have a stake in the industry, but are usually excluded from the initial allocation of quotas. Further, some in Iceland question the morality of permanently allocating fishing rights to individuals, thereby precluding future generations from similar opportunities.

Lessons for tradable permit markets

Early tradable fish quota programs demonstrated that "tragedy of the commons" problems could be solved by privatizing and distributing shares of a public good and allowing the market to subsequently redistribute a fixed quota among potential users. Generally, the programs are viewed as successful and have influenced subsequent tradable permit schemes. The practical experience of implementing similar, but not identical programs over a period of time in several countries provides several important lessons.

The value of tradable permits is dependent on the regulatory institutions that create them. Consequently, the "rules of the game" and their future stability are key determinants of the success of such programs. The privatization of a common resource and the early use of tradable quotas was accepted largely because spectacular failures of fisheries elsewhere drove fishermen to look for a viable solution. Tradable quotas were one of many policy experiments; but the approach gained popularity because they were viewed as successful and efficient.

By privatizing a common resource, the fish-quota programs created and conferred wealth to individuals. Successful programs were inclusive in the allocation process. At the same time, the general process was shaped by local and somewhat arbitrary views of fairness and in most cases ended in considerable deal making and bargaining.

There are several important lessons to be drawn about how tradable permit markets evolve. The first is that market participants quickly differentiated between the asset value of the underlying quota share, and its seasonal value. In New Zealand, this resulted in a formal distinction between the permanent quota right and the annual catch. Second, it is difficult to initially price tradable quotas when the program is established. Uncertainty about the program itself and the effects of the program combined with new markets for the quotas themselves resulted large price movements over time. Finally, while uncertainty about the overall size of the annual catch probably complicated price forecasting, functioning markets for both annual quotas and long-term quota rights did emerge.

Table 3: Characteristics of selected tradable fish quota programs.

Country	Starting date	Number of species covered	Market share restrictions	Other restrictions	By-catch provisions	Banking/ borrowing
Australia						
tuna	1984	1				
orange roughy	1989	1	yes[33]	yes[34]	no	no
South East fishery	1992	16[35]	yes[1]	yes[2]	no	no
Canada						
BC halibut	1990	1	yes[36]	yes[37]	no	no
Iceland						
herring	1979	1	yes[38]	yes[39]	no	no
capelin	1986	1	yes[4]	Yes	no	no
demerol	1990	1		Yes	no	no
New Zealand	1986	33	yes[4]	yes[40]	yes	yes, currently
United States[41]						
clam & quahog	1990	2	no	yes[42]	no	no
wreckfish	1992	1	no	No	no	no
halibut & sablefish	1995	2	yes	yes[43]	no	no

2. Leaded gas phasedown

Background[44]

In the 1970s, lead contained in gasoline was the primary source of environmental lead in the United States. Lead is toxic to humans and also breaks down the catalytic converters used to reduce automobile emissions. In 1973, the US EPA launched a Lead Phasedown Program, designed to reduce lead content in gasoline and to create incentive for refineries to switch to producing unleaded gas. The 1973 regulation set a maximum average lead content for refined gasoline. The average allowed pooling of leaded and non-leaded gas production. By 1982, unleaded gasoline was widely available and EPA introduced more stringent controls. At the same

[33] ITQs must be matched with licenses.

[34] Zonal restrictions, gear restrictions.

[35] The orange roughy ITC was subsumed under the Southeast fishery ITQ program in 1992.

[36] Quotas were linked to vessels.

[37] Transferability was also limited and phased.

[38] Quotas are allocated to vessels, not individuals. Vessel entry is limited by license.

[39] To stabilize local employment, there are restrictions on transferring quotas out of the region.

[40] 75% domestic ownership.

[41] Regional programs.

[42] No quota transfers during the last two months of the season.

[43] Restrictions on leasing, on transfer between vessel categories, on transfer between management areas and minimum quota size.

[44] This section relies heavily on Lambert (1996) and Hahn and Hester (1989).

time, the program created rights to add specified quantities of lead to gasoline and permitted trades in those rights among refineries.

The EPA objective was to reduce the lead content of a gallon of gasoline to less than 0.10 grams per leaded gallon (gplg) through a series of phased steps. 1982 limits were set at 1.10 gplg; limits were set at 0.50 gplg on July 1, 1985. All refiners without extra allowances were expected to reach 0.10 gplg by July 1986.

How the program worked

Starting in 1982, the EPA set the gplg standard at 1.10. Small refiners were given a grace period to meet the standard. The program generated allowances to add specific amounts of lead, which were award to refineries based on historic production levels. Refineries with excess allowances were allowed to sell to refiners in deficit. Traded allowances accounted for 7% of the market in 1983 and 20% of the market in 1984.

Originally, unused allowances simply expired. However, beginning in 1985, firms were allowed to hold in inventory, or "bank", unused allowances for use until the end of 1987, at which time all gasoline would have to meet the 0.10 gplg standard. At the same time, EPA announced it would tighten the standard from 1.10 to 0.50 gplg in July 1985 and to 0.10 in July 1986.

The introduction of banking dramatically altered the market for allowances. Refiners were anxious to bank allowances in anticipation of the tightening standards. The number of lead rights traded as a percentage of lead used increased sharply from 20% in the first quarter of 1986 to 60% in the second quarter of 1987 (Hahn and Hester, 1989; Klaassen, 1996). The price of lead rights jumped as well, moving from 0.75 cents gplg to more than 4.0 cents gplg (Nussbaum, 1992; Klaassen, 1996).

Moreover, some smaller refiners began blending alcohol to their gasoline in order to more rapidly reduce the lead content and generate surplus allowances -- an unforeseen outcome of the new program. Allowances were banked early and average lead levels dropped to 0.70 in the first quarter of 1985, well below the prevailing standard. The industry met the 0.50 gplg standard well ahead of schedule. When the 0.10 standard arrived in July 1986, refiners used banked credits to temporarily exceed the standard. By the end of 1987, as the allowances expired, all refiners complied with the 0.10 standard and no refiner requested additional time to meet the new standard..

The program was not without its problems. The EPA failed to provide a certification mechanism for creating surplus allowances and some refiners produced bogus allowances for sale as prices rose. Computer systems became inadequate as the number of gasoline blenders rose. The EPA faced a backlog in reviewing reported lead rights data and tracking potential violators proved labor intensive. Still, the EPA estimated that the trading provision saved the refining industry $65 million in compliance costs while the banking provision reduced compliance costs by an additional $226 million (Nussbaum, 1992). Klaassen (1996) estimates the cost savings at about $300 million -- a cost reduction of roughly 20%.[45]

[45] Originally, EPA estimated that the program (without the banking provision) would cost the refiners about $2.6 billion (in 1983 dollars) against a $36 billion savings in health costs for the general public.

Lessons for tradable permit markets

The lead phaseout program was one of the first experiments by a government regulatory agency in traded emission rights. The program was largely successful and proved cost-effective. Importantly, the phased exit strategy generated a remarkably smooth transition.

The program demonstrated that pollution externalities can be internalized through legislation and markets can be used to reallocate emission rights to achieve efficiency gains. Because the program achieved environmental goals efficiently, it became the prototype for subsequent US national and regional programs. The program also demonstrated that inventories resulting from banking provisions can allow traders to arbitrage inter-temporal price differences in a way similar to traditional commodity markets. The program also showed that failure to clearly certify allowances eligible for trading creates opportunities for fraud and therefore clear certification procedures have been a corner stone of subsequent trading schemes.

3. Sulfur dioxide allowances in the United States

Background

During the 1980s, nearly 70 bills were introduced in the US Congress to address the issue of acid rain. The debate ultimately resulted in Title IV of the more comprehensive 1990 US Clean Air Act Amendments that provided for a cap-and-trade allowance system to control sulfur dioxide (SO_2) emissions. The first phase of the program began in 1995 and covered the largest sources of emissions. The second phase is to begin in 2000.

Significantly, the approach departed from the traditional command-and-control approach that had dominated US pollution policies. Based on an early cap-and-trade program that operated during the phase-out of lead in US gasoline, the program was also significant in the scale of the program. The program aims at ultimately reducing SO_2 emissions by 40% from 1980 to 2010 by monitoring more than 2,000 emission sources. The program is broadly viewed as successful and has been the basis of regional programs in the Los Angeles basin, Chicago, and the Northeast states.

Tradable allowances are the cornerstone of EPA's Acid Rain program and their introduction proved controversial. The trading provision was based on the earlier success of the lead phase-out program and the *offset* and *netting* provisions of the Clean Air Act. However, at the time, the results of the limited practical experiences of tradable emission permits were mixed[46]. Further, the basic morality of trading pollution permits was challenged by some. Kruger and Dean (1997) cite a USA Today editorial declaring that "people will die" because of allowance trading.

Early environmental benefits help stemmed opposition. The largest one-year drop in SO_2 emissions took place in 1995, the first year of the program. Moreover, the some of the highest emitting areas of the United States in Ohio and Indiana experienced the sharpest reductions. Figure 11 summarizes annual SO_2 emissions. Since that time, there has been a growing acceptance and support for cap-and-trade systems in the United States as an effective and efficient mechanism for limiting emission. In turn, this experience has shaped the US support for tradable permits in proposed international treaties to limit greenhouse gases.

[46] See Hahn and Hester for an analysis of both programs.

How it works

The program sets emissions standards for electric utility boilers based on historic 1985-87 average production levels and standard SO_2/BTU emission rates.[47] Allowances -- or emissions permits-- are issued based on this formula and cover thirty years.[48] An allowance authorizes[49] an owner to emit one ton of SO_2 during a given year.[50] If unused, the allowance can be banked for future use or traded.

Although regulators use historic output to determine allowance allocations, future allocations and use of the allowances are not linked. Utilities do not have to continue to operate old boilers -- or any boilers -- in order to qualify for allowances. All utilities must match emissions with allowances.[51] Failure to comply results in heavy penalties and an equivalent reduction in future allowances.[52]

The program required 110 utilities operating the eastern and mid-western states of the US to limit emissions from 263 large coal-fired boilers beginning in 1995 under Phase I of the program. In 2000, Phase II of the program begins at which time all of the estimated 2,050 electric utility boilers in the US (with an output capacity of 25 megawatts or greater) will be subject to similar restrictions. These boilers account for about 99% of SO_2 emissions. Overall program limits are given in Table 4; however the totals are subject to some modification. Allowances can be created under other components of the program, including scrubber and conservation incentives and opt-in programs.

The basic allocation for Phase I boiler units is approximately 5.5 million allowances for each of the years 1995-1999. However the program provides 3.5 million extra "bonus" allowances to be allocated in Phase I as an incentive for utilities choosing to build Flue Gas Desulfurisation systems (scrubbers) which reduce SO_2 emissions by 90% to 95%. Bonus allowances will continue in each of the years 2000-2009. Bonus allowances will not exist after 2010, when the 8.95 MT cap comes into effect.

In addition, "new" allowances can be generated through two voluntary programs. The substitution program allows Phase II affected utility units to voluntarily enter Phase I of the Acid Rain program. The opt-in program allows all operating stationary combustion sources that emit SO_2 but are not required to meet emission limits to voluntarily enter the program. Both voluntary programs entice facilities with low-cost abatement to enter the program in exchange for allowances. As added incentive, Phase II facilities "opting in" are able to grandfather NO_x emissions that are subject to separate regulations. In some cases, the allowance serve as

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47 Start-ups between 1987 and 1995 are allocated allowances based on a similar formula. Boilers put in use after 1995 do not qualify for allowances.

48 Permits for the "31st year" are issued annually.

49 Allowances are considered permits, rather than rights or property, and the government retains the option of recalling the allowances. Nonetheless, allowances are actively bought and sold.

50 The term "vintage" refers to the year in which the permit is first eligible for use.

51 For example, in 1997 firms must have a total of 1997 and earlier vintage allowances registered with the EPA that match or exceed measured 1997 emissions.

52 The penalty for non-compliance was set at $2,000 per ton in 1995 and was indexed to inflation. The current 1997 penalty is about $2,500 per ton. In addition, violating utilities must off offset excess emissions with an equivalent amount off allowances. Utilities were 100% compliant during the first two years of the program.

compensation rather than incentive. Because of separate state regulations, some facilities face more stringent emission controls anyway and opt-in to receive allowances.

Costs and expectations

Administration of the program requires about 150 full time EPA staff, costing $60 million in administrative costs for the first five years -- roughly $1.50/ton of carbon reduction (Mullins, 1997.) The cost of monitoring is relatively high. Continuous monitoring costs are estimated at $120,000 per stack. Moreover, 1995 monitoring constituted about 7% of compliance costs (Kruger and Dean, 1997). Individual projects can face much higher costs. A case study from New England Power[53] reports total capital costs for continuous monitoring systems on 11 units averaged $6 per kilowatt of capacity. Still, proponents argue that in addition to measuring compliance, the monitoring also produces information that facilitates the markets for allowances, leading ultimately to lower compliance costs.

In fact, the US Government's General Accounting Office (GAO, 1994) estimated that the cost of compliance with emission limits at $2 billion a year. The same report estimated compliance costs under an alternative command and control approach at $4.9 billion and attributed the cost-savings to expected savings from allowance trading. The report also suggested the costs of the program could drop to $1.4 billion should market prices for the tradable allowances fall. That indeed appears to be the case.

The price of an allowance to emit one ton of SO_2 was valued by the EPA at $1,500 in 1990, but allowances traded at $150/ton as Phase I began in 1995 and dropped to $66/ton in 1996. In late 1997, spot prices had recovered to about $104/ton (Table 5.) Analysts suggest several reasons for the price declines[54]. Primarily, market developments reduced the cost of abatement. New investments in railroad infrastructure lowered the cost of delivering low-sulfur coal to many plants. Additionally, natural gas and the scrubber industry found cost reductions as well. (Burtraw, 1996; Ellerman and Montero, 1996.) Transaction costs, which Doucet and Strauss (1994) suggest were as high as $10 per allowance prior to auctioning, have dropped to as low as $1.75 per allowance (Zorpette, 1994.) And, importantly, additional allowances issued as incentives for installing scrubbers and for voluntary early inclusion have boosted supply. (Conrad and Kohn, 1996.) Additional local regulations may have depressed the demand for allowances as well. In some cases, the policies have been explicit-- for example, specifying the use of local coal, or imposing specific technology, or granting accelerated depreciation of scrubber capital costs. However, Bohi (1993) and Klaassen (1996) argue the tendency for regulators to allow utilities to earn a return on scrubber capital costs while treating allowance costs as fuel costs creates a general bias toward scrubber technology. Further, Rico (1993) points out that utilities that owned both Phase I and Phase II plants could generate Phase I emission reductions simply by shifting production.

Trading

After a slow start, allowance purchases have grown to more than 5 million in 1995/96. Currently more than 25% of all utilities and 50% of Phase I utilities have engaged in a trade with

53 Kenison reported in Atkeson, 1997.

54 See Conrad and Kohn for review of various explanations for the decline in allowance prices.

another utility, broker or fuel company. In addition, there are seven companies offering brokerage services. Moreover, about 20 different groups have purchased and voluntarily retired about 1,400 allowances.

In March 1994, the US Environmental Protection Agency (EPA) launched an Allowance Tracking System. Trading is open to all; however trades must be registered ex post with the EPA[55]. Subsequently, trading data are posted on a public Web site.[56] An average trade registration is completed in 30 minutes and all trades are registered within 24 hours. The ATS lists all parties to the transaction as well as the vintage of the allowance trade, but does not record trade prices[57]. However, recently private traders have begun to provide indicator prices to the public.

Originally, program developers expected that a formal futures market would evolve on the Chicago Board of Trade (CBOT). Indeed the EPA held back about 2.8% of the allowances to guarantee access to allowances for new entrants and to facilitate price discovery through annual auctions administered by the CBOT. The CBOT announced in 1992 its intention to offer futures and options contracts and the first auction was held in 1993[58]. However, from the start, the auction proved problematic. EPA interpretation of legislative guidelines resulted in an process that appears to encourage low offers[59] (Klaassen, 1996.) Solicited bids (demand) are lined up from high to low and asks (supply) from low to high. The lowest asking price is matched with the highest bid and cleared. Then the next pair are matched until remaining bids no longer exceed remaining asks. As a result, firms that present relatively lower asking prices receive relatively *higher* prices for their auctioned sales.

Contrary to expectations, the market for allowances evolved into an over-the-counter market comprising primarily brokers and utilities. (See Figure 12.) Such a structure is consistent with the Phase I world of SO_2 trading, where there are relatively few major buyers and sellers and counter-party risk has not proved crucial. Still, early on, price discovery proved difficult and transaction costs were high (Klaassen, 1996). However, in recent years, brokerage firms have emerged to handle a significant share of the market, information has become more readily available and transaction costs have fallen (Walsh, Ramesh and Ghosh, 1996.)[60]

Another striking characteristic of the market for allowances is the small negative spread between spot and forward prices. Early analysts had projected rising prices through time as SO_2 requirements became more stringent; however the banking provision allows firms to reduce future costs by saving allowances early, effectively arbitraging costs over time (Klaassen, 1996.) Nevertheless, because of the time-value of money, holding current allowances in inventory is costly. One explanation of the negative return to storage may lie in the callable nature of the

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55 Buyers and sellers must either register as agents with the EPA directly or deal through a registered trader.

56 The ATS can be accessed at: http://www.epa.gov/docs/acidrain/atsdata2.html.

57 See the discussion of the US SO_2 program in Annex ?? for a discussion of permit vintages.

58 Non-auction trades were underway before the first auction when in May 1992 Wisconsin Power and Light traded 10,000 allowances to the Tennessee Valley Authority.

59 Allowances auctioned come from a pool of withheld allowances and proceeds from the auction accrue on a pro rata basis. McLean (1993) argues that the method was motivated by politics to insure that Midwestern utilities -- expected to be net sellers-- would receive most of the revenues.

60 Centre Financial and Cantor-Fitzgerald are significant brokers of cash trades and option contracts are available from Cantor-Fitzgerald and Enron.

allowance. Though most in the industry expect no significant program changes, the EPA retains the authority to limit, revoke or modify the allowances without compensation.

Lessons for tradable permit markets

The US Acid Rain program is the most studied and well known of the tradable emissions programs. It is widely viewed as successful because environmental goals have been met while costs have fallen below expectations. Its success has heavily influenced US policy toward international efforts to control green house gas emissions.

The program provides several lessons about the political economy and institutional arrangements of tradable permit schemes. First, the program was successful in achieving environmental goals in an area where success had been elusive. This was especially remarkable given the lack of widespread initial support for the program. However, by creating and distributing wealth in the form of permit assets, the Acid Rain program created a vested interest of many of the major players in the success of the regulatory process. Further, because of the banking provision, the program produced early and significant positive environmental effects. The program and subsequent analysis also demonstrate the value of information -- especially pricing information -- on the cost of doing business. Even though the initial vehicle for price discovery, the auction, proved flawed, private intermediaries emerged to take up the function. The program also points out the value -- and potential high cost -- of monitoring and registration. On pricing, the program demonstrates again the difficulty for policy makers to predict the price of allowances prior to their launch. By implication, this means that regulators have only poor estimates of the cost of controlling emissions. In the case of SO_2 allowances, the relationship between low-sulfur coal, scrubbers and program incentives lead to unpredicted outcomes and lower-than-expected allowance prices.

Table 4: Sulfur dioxide emission limits under the US Acid Rain program.

Year	Allowance Limit
Phase I	*million tons SO_2*
1995	7.10
1996	7.00
1997-99	6.00
Phase II	
2000-09	9.48
2010	8.95

Figure 11: Sulfur dioxide emissions by regulated US utilities.

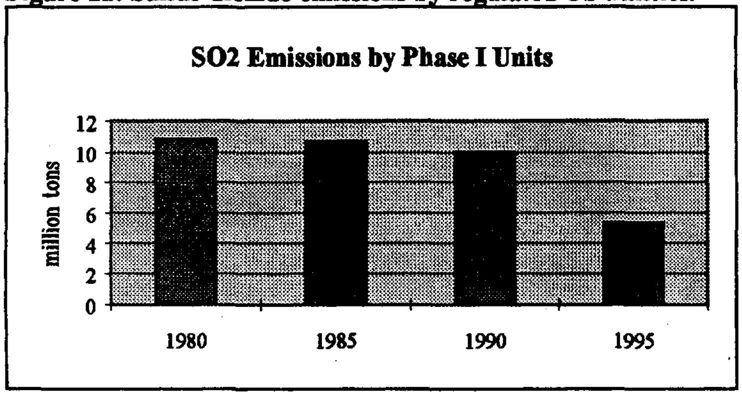
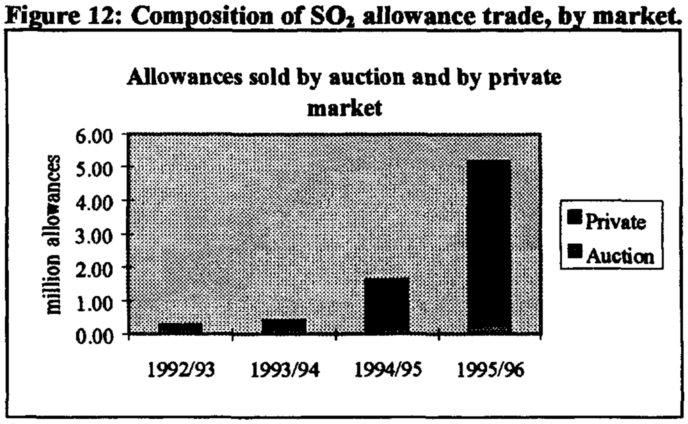


Table 5: SO_2 emission allowance prices.

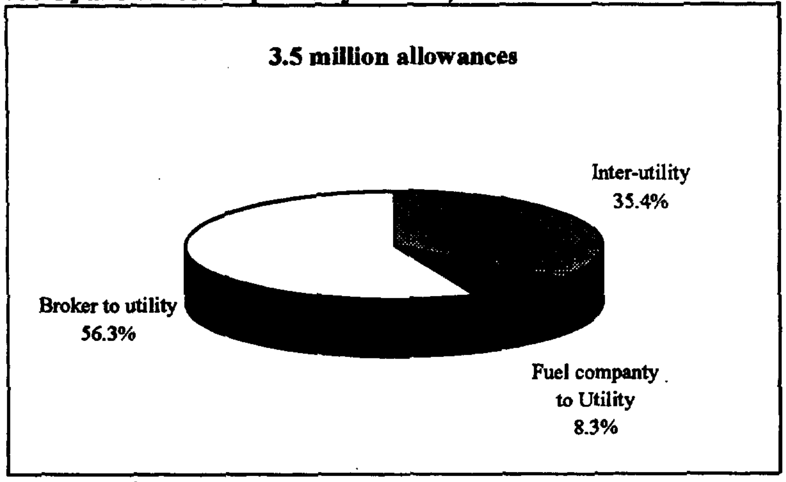
	nearby*	6-year forward	7-year forward
	Clearing price $/ton SO_2		
1993	156.00		
1994	150.00	140.00	140.00
1995	130.00	128.00	126.00
1996	66.05	64.15	63.01
1997	106.75	105.15	102.15

Figure 12: Composition of SO_2 allowance trade, by market.



Source: Bailey et. al reported in Atkenson, 1997.

Figure 13: SO_2 allowances acquired by utilities, March 1994 to March 1997.



Source: Kruger and Dean (1997).

4. The Dutch covenant with electricity producers

Background[61]

In 1990 the national government and the 12 provinces of the Netherlands signed an agreement, or covenant,[62] with the association of electricity producers (Samenwerkende Electriciteits Producenten, or SEP) to reduce sulfur and nitrogen oxide emission by the year 2000. Acid rain, a consequence of acidifying pollutants, is a regional problem and plants were already subject to emission regulation; however, the covenant further reduced total emissions on aggregate emissions from public power plants. The goal of the covenant is to reduce SO_2 emissions from 1989 levels of 41 to 18 ktons by 2000, and to reduce NO_x emissions from 74 to 30 ktons. The Covenant does not establish a system of tradable permits; however the system has similar characteristics, since, beneath the bubble, firms are free to negotiate rights to emit.[63]

How the system works

The electricity sector in the Netherlands is a cartel of mixed public ownership. Public authorities own the companies that distribute electricity. In turn, the distribution companies, provincial governments and local authorities own the four electricity producing companies in the Netherlands. Decisions regarding fuel use and plant utilization, as well as the price of electricity delivered to the distribution companies are made by SEP.

The covenant sets goals for the sector, but leaves implementation strategy to SEP, with the following exceptions: 1) all existing plants must meet minimum emission standards; and 2) relatively new plants are required to meet a second set of higher standards.

The goals are established by the covenant are not strictly binding. First, SEP can increase the NO_x cap up to 5 million kg by supplying heat from combined heat and power generating plants. The sulfur cap can also be exceeded by 4 million kg if scrubbers fail. Moreover, these modified ceilings can also be exceeded by 3 million kg once every three years. In addition, the covenant itself can be altered under certain circumstances.

The covenant requires SEP to establish an action plan for achieving the goals of the agreement. In turn an expert commission established by the Ministry of the Environment, the SEP and the provinces reviews the plan. The SEP reports back to the commission every two years. Individual producers report to the provinces and to the SEP. Provinces can defer implementing the covenant in order to pursue other air quality standards. Parties can alter the covenant and the ceilings due to unexpected environmental events or if electricity demand or imports differ from projections. Further the covenant can be scrapped altogether if the ceilings cannot be met by reasonable means, or if the parties fail to agree on the action plan.

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[61] This section relies heavily on Klaassen (1996).

[62] Covenants are negotiated agreements with the status of binding contracts in civil law. Between 1990 and 1995, the Government of the Netherlands negotiated fifteen sector agreements designed to meet the goals of the National Environmental Policy Plan of the Netherlands.

[63] Beginning in 1996, some energy-intensive industries were offered tax relief conditional on meeting voluntary energy-saving goals.

Expected cost savings

According to the electricity producers, the covenant is expected to cut costs by 50% when compared with setting stricter emission standards. The savings come from achieving greater-than-required emission reductions at those facilities with longer remaining lifetimes. Klaassens (1996) raises doubts about the cost-minimizing behavior of the industry however pointing out the lack of competition among electricity generators, and the linked ownership. However, some competition does exist among distributors and large consumers are free to chose among distributors.

Lessons for tradable permit markets

The Dutch Covenants represent an alternative way of providing firms with an opportunity to devise cost minimizing ways of meeting regulatory goals. The agreements are especially appropriate to the Netherlands' integrated energy sector. Traded-permit solutions generally presume a number of independent profit-maximizing agents, attributes that do not characterize the Dutch electricity market. Interestingly, the Dutch Covenant program will provide one test of whether free markets are a precondition for solving this particular form of market failure.

It is too early to pre-judge the efficacy of the agreement. Certainly there is scope for avoiding emission goals. In addition, critics of the Covenants have argued that the process encourages regulators to concentrate on evaluating the environmental action plan of regulated companies, rather than monitoring emissions (Hersh, 1997.) Still, the Covenant does provide an alternative model that introduces the potential for cost minimizing behavior.

5. Regional clean air incentive market[64]

Background

In 1994 the South Coast Air Quality Management District (SCAQMD) introduced the Regional Clean Air Incentives Market (RECLAIM) in the Los Angeles basin. The program was designed to improve air quality through the reduction of nitrogen oxides (NO_x) and sulfur oxides (SO_x).

The region has the poorest air quality in the United States. Despite 50 years of regulation, the region, in 1994, was the only area in the nation classified "as a severe non-attainment area" for failing to meet current ozone standards (Prager, Klier and Mattoon, 1996.) Although significant improvements were accomplished under earlier programs, the gains were overwhelmed by regional growth. Moreover, mobile sources such as cars, trucks and buses generated more half of the NO_x and reactive organic compounds, both ozone precursors, but were not subject to SCAQMD controls. (Hall and Walton, 1996.)

Prior to the RECLAIM program, the AQMD regulated and monitored individual equipment in each facility emitting NO_x and SO_x. Faced with the need to meet federal clean air standards, AQMD estimated that it needed to reduce NO_x and SO_x emissions by 80% by 2003. AQMD considered the cost and economic impact of a variety of solutions (Johnson and Pekelney, 1996) and estimated that a system of traded allowances would provide the most cost-effective way of reaching emission goals.

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[64] See Prager, Klier, and Matton (1996) for a more complete review of the history and early results of RECLAIM.

How the system works

RECLAIM is a facility-specific, cap-and-trade program. All facilities generating four tons per year or more of NO_x and SO_x are subject to the RECLAIM cap. Initially, the program covered 390 NO_x facilities and 41 SO_x facilities. Under the program, each facility was given an allocation of credits covering each source of emissions. The credits were time-stamped so that the credit could only be used during a specified year. Credits could not be "banked" -- that is, saved for use in future years. Each year, firms were required to match credits with emissions from their facility. Equipment-specific requirements were dropped.

Firms are allowed to trade credits; however two zones were created, one coastal and one in-land. All facilities can freely trade credits within zone, but because of prevailing winds and weather conditions, coastal zone facilities cannot acquire credits from in-land facilities.

The allocation of credits was based on an initial starting level based on historic emissions (base-year), subject to scheduled facility-specific reductions based on requirements and goals under the command system in place prior to RECLAIM.[65] Credits were issued for 1994 to 2010. As a result, while emissions were expected to fall on average by 80%, rates of reduction varied across firms. Selecting the base-year proved contentious and ultimately the program designers allowed each firm to chose one of the four years, 1989 to 1992, as its base year. This resulted in greater acceptance of RECLAIM, but also resulted in higher 1994 emissions.

There is also a provision for entry or expansion. New facilities, facilities that are relocated or facilities that increase their emissions are subject to best available technology restrictions and must acquire additional credits. New credits can be generated through a program that scraps old cars and trucks subject to a 30,000-vehicle limit.

Expectations and market prices

Before RECLAIM began, savings were expected to be significant, especially early in the program. Still, initial monitoring costs were expected to range from $1,500 for a minor source to nearly $200,000. Large sources use continuous emission monitors and all facilities are visited by inspectors at least three times a year.

Early on, because of the flexibility granted to facilities in choosing their base-year and the declining allocations for future-dated allowances, planners expected future-dated allowances to trade at a high premium over near-term allowances. Moreover, based on abatement cost estimates, allowances were expected to trade at prices trade at $4 to $5 per pound for NO_x and $1 to $2 per pound for SO_x in 1987 dollars. Prices above $6.70 per pound were to trigger a review of the program's efficacy. Table 6 reports the outcomes predicted by the planners' economic model.

So far, emission allowances have traded at prices well below expectations and compliance costs are well below predicted levels. To date, the highest amount paid for an auctioned allowance was $1.04/pound -- in nominal dollars-- for a 2003 allowance. Figure 14 reports NO_x auction prices converted in 1987 dollars.

[65] SCAQMD produces a Air Quality Management Plan every three years. The 1991 plan became the basis for budgeting facility-specific future emissions.

How the market for credits works

Other than the prohibition on coast-inland trades, there are no significant restrictions on how credits are traded. The trades do have to be registered with SCAQMD once they occur, but SCAQMD doesn't auction or broker credits. Entities other than RECLAIM facilities are free to participate in the market. Two private firms, the Automated Environmental Credit Exchange (ACE) and the Clean Air Auction (CAA) handled most of the brokered trades. Cantor Fitzgerald runs CAA and ACE is managed by Sholtz and Associates, a consulting firm in cooperation with the Pacific Stock Exchange. ACE operates over the Internet and features five days of trading every quarter.[66]

Data on registered trades is available and has been analyzed by several authors. Gangadharan (1997), and Prager, Klier and Mattoon (1996) find that early markets were thin and information scarce -- driving up search costs. In at least one case in August 1995 Cantor Fitzgerald was unable to place an offer by Union Oil and returned the credits unsold. A lack of market information seemed to coincide with a more general lack of understanding by some participating firms. During the first year of the program about 14% of the facilities failed to meet standards -- despite the availability of low-cost credits.

More recently trading information has become more readily available and volumes have increased. SCAQMD provides an electronic bulletin board where bids and asks can be posted[67]. ACE provides on-line trading information and information, and Cantor Fitzgerald offers a WEB page with a ticker running at the bottom with current prices. Through 1996, about 50% of the facilities traded NOx credits. However only 33 facilities (about 9%) both bought and sold credits. This group accounted for 75% of the 1995 vintage credits sold and 85% of the 1995 credits bought.

Lessons for tradable permit schemes

RECLAIM has provided dramatic reductions in SOx and NOx emissions and has done so in a cost-effective manner. The failure of the earlier "command" system to reduce emissions, the threat of EPA non-compliance consequences and the promise of flexibility and low cost created the political will to define strict standards. As with other permit schemes, the creation and distribution of tradable assets also gave the regulated an incentive to support the regulatory structure. Allowing temporary increases in emissions in exchange for long-run reductions also eased acceptance. Early results, backed by a reliable monitoring system also garnered community support.

The program also demonstrated the difficulty of establishing estimates of program costs and allowance prices prior to implementation. Ex ante estimates proved to be highly inflated. Monitoring costs are high, although the monitoring data is highly valued by the market. The program also demonstrated the importance of market information. Early on information, especially information about allowance transactions, was difficult to obtain and raised transaction costs. Subsequently, private brokerage firms emerged, and public regulators increased efforts to distribute market information resulting in lower transaction costs.

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66 With private brokers came trading in *noxs* and *soxs*.

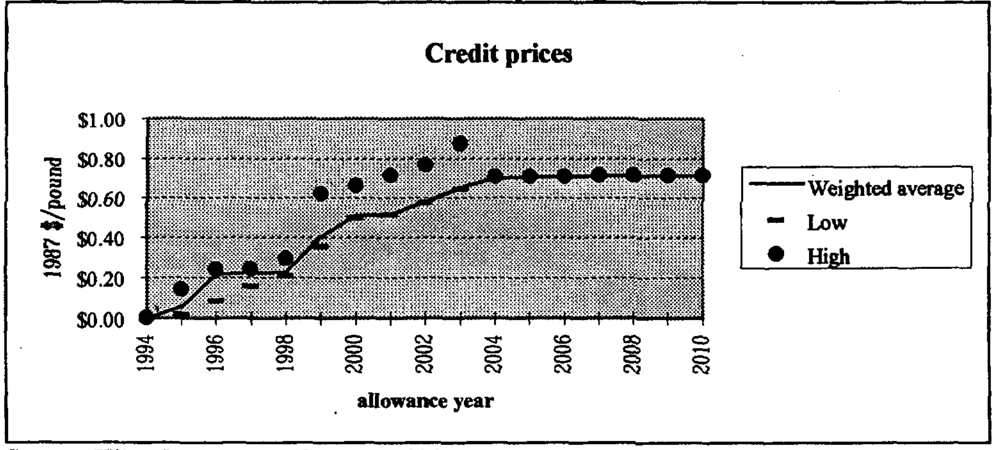
67 See Cason and Gangadharan (1997) for an experimental study of the bulletin board system and price discovery.

Table 6: Expected prices and compliance costs.

Year	RTC prices		Compliance Costs		Jobs foregone	
	NOx	SOx	savings	Rec/CAC	Reclaim	CAC
1994	$ 0.26	$ 0.26	$ 38.2	21%	(771)	347
1995	$ 0.26	$ 0.68	$ 97.8	12%	(716)	89
1996	$ 4.21	$ 2.79	$ 46.6	62%	(674)	2,619
1997	$ 4.09	$ 1.37	$ 32.9	74%	2,205	3,332
1998	$ 3.96	$ 1.33	$ 67.7	65%	1,990	2,569
1999	$ 5.03	$ 1.29	$ 64.0	72%	3,163	3,096

Notes: Prices are in 1987 $US/pound; compliance cost savings are in 1987 $ millions.
Source: Johnson and Pekelney, 1996.

Figure 14 : Auction prices for NO_x credits, by vintage.



Source: Klier, Mattoon, and Prager (1997)

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